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SEGMENTAL LOCALIZATION OF PULMONARY DISEASE*

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SEGMENTAL localization of pulmonary disease can be accurately accomplished in practically all instances utilizing only the posteroanterior chest roentgenogram. This concept has been described previously[3,5,7,15] and the importance of a knowledge of bronchopulmonary anatomy has been emphasized in the diagnosis and treatment of pulmonary disease.[6,8,11] Most of the past accounts of bronchial anatomy were illustrated by drawings or diagrams which were sometimes inaccurate[2] and often these inaccuracies were handed down from one author's reference to another's. These earlier accounts often made use of roentgenograms demonstrating lung abscess, tuberculosis, or atelectasis in an attempt to demonstrate segmental involvement.[8–14]

In the authors' opinion, segmental anatomy of the lung is well demonstrated roentgenographically by acute pneumonic infiltration. Although there is undoubtedly some distortion or volume change produced by pneumonia, it is usually less than that found in other pathologic processes.

The roentgenograms in this report are representative examples of segmental infiltration obtained from approximately 4,500 cases of pneumonia observed over the past three years at the United States Air Force Hospital, Lackland Air Force Base, Texas. The diagrams represent the average appearance of the segmental pneumonias which we have observed. The diagrams, in some respects, are at variance with previous reports. The authors feel that this variation is justified on the basis of their observations (Plate I, II, III and IV).

GENERAL ROENTGENOGRAPHIC CONSIDERATIONS

Accurate localization of the pulmonary infiltrate on the posteroanterior chest roentgenogram depends upon a knowledge of the distribution of the segmental bronchi and the surface anatomy of the segments in relation to adjacent intrathoracic struc-

* This paper represents the personal viewpoint of the authors and is not to be construed as a statement of Official Air Force policy.

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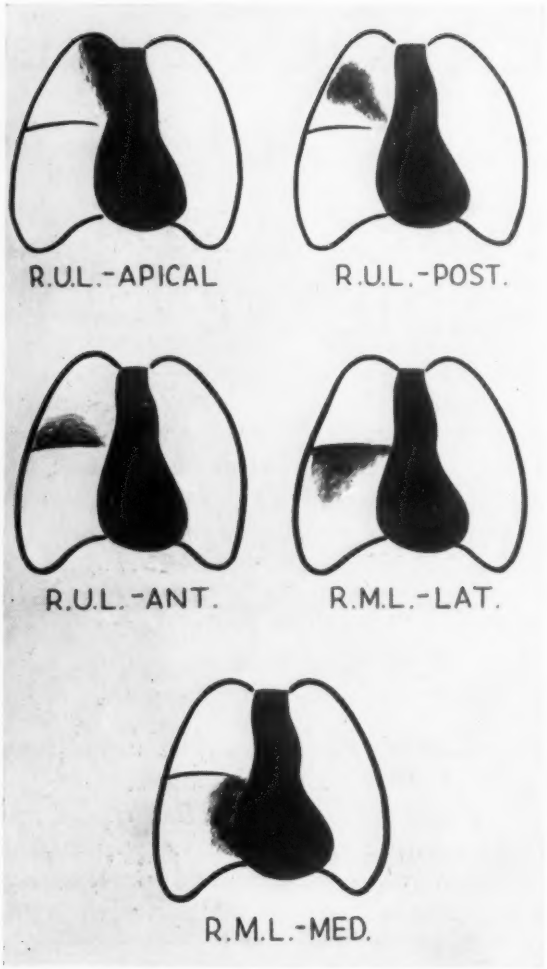

PLATE I (see Fig. 1–5).

tures.[1,4] The knowledge of the surface anatomy has proved especially valuable in differentiating segments which overlie each other in the posteroanterior projection. Robbins and Hale[8–14] first observed that a collapse of a lobe or of a segment of the lung contiguous with the heart obliterated its border. This observation was extended by Felson and Felson[3] to include intrathoracic densities either of pulmonary, pleural, or mediastinal origin. They noted that the border of the heart, the aorta, the aortic knob, and the diaphragm might be obscured when the diseased portion of the lung was immediately adjacent to one of these structures (silhouette sign of Felson). Rigler[7] described the diagnostic importance of changes in the density of the cardiac shadow.

These principles make reasonably accurate localization of pulmonary infiltrates possible when viewed from the posteroanterior projection alone.

ROENTGENOGRAPHIC DESCRIPTIONS

A brief description of the segmental appearance of pneumonia in each of the bronchopulmonary segments is presented. Each is illustrated by a typical roentgenogram and a composite diagram.

RIGHT UPPER LOBE

Apical Segment (Fig. 1). The infiltrate is in the medial portion of the right lung involving the extreme apex and blends into

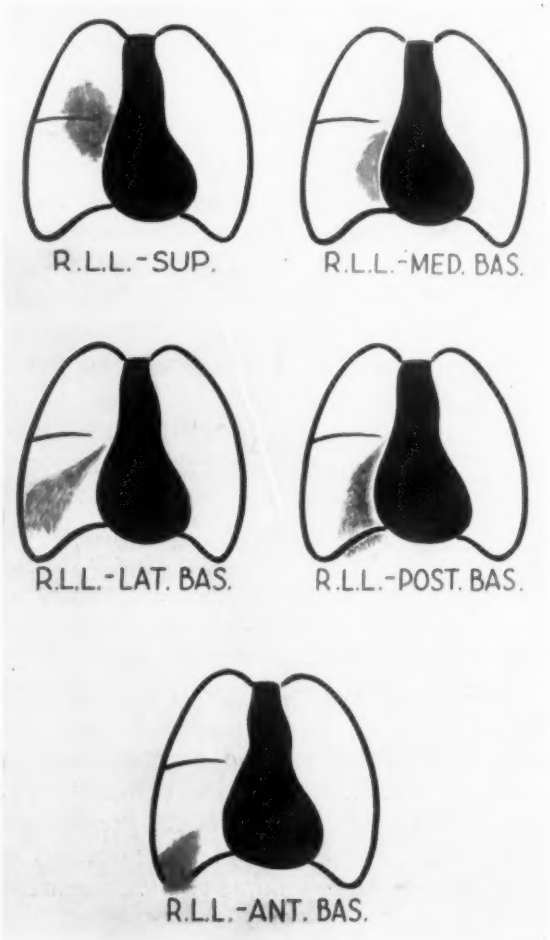

PLATE II (see Fig. 6–10).

the shadow of the superior mediastinum.

Posterior Segment (Fig. 2). This density extends obliquely upward and outward from the right hilus into the lateral retro- and infraclavicular areas. It does not extend below the horizontal fissure and the right hilus usually remains clearly outlined (as does the rest of the mediastinum).

Anterior Segment (Fig. 3). This is the largest of the segments of the right upper lobe. It is bordered distinctly on its inferior aspect by the horizontal fissure. The ascending aortic and right hilar shadows may be indistinct because they are contiguous structures (hilar shadow sign).

RIGHT MIDDLE LOBE

Lateral Segment (Fig. 4). This segment is bordered distinctly on its superior aspect by the horizontal fissure and fades out as it extends inferiorly and medially.

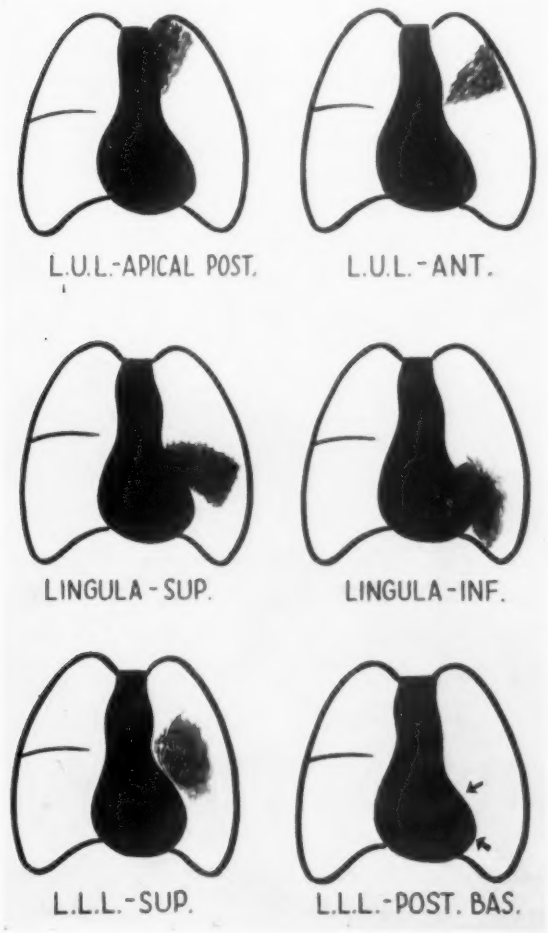

Plate III (see Fig. 11–16).

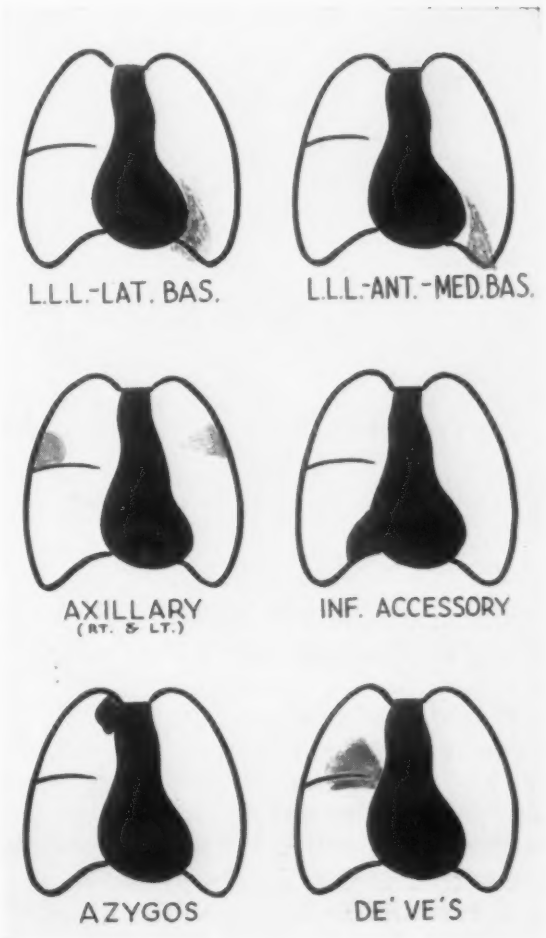

Plate IV (see Fig. 17–22).

Medial Segment (Fig. 5). The shadow blends with the right cardiac border and may extend to the anteromedial portion of the right diaphragm. It becomes indistinct laterally and superiorly. The lower portion of the right hilus is indistinct.

RIGHT LOWER LOBE

Superior Segment (Fig. 6). When the complete segment is involved, the infiltrate occupies the right mid-lung field, both above and below the horizontal fissure. Very often, however, it is subsegmental in distribution and is confined to an area immediately behind the right hilus. The right

Fig. 1. Right upper lobe. Apical segment.

cardiac margin and the ascending aorta are clearly outlined and usually the right hilus is identified.

Medial Basilar Segment (Fig. 7). This segment is the most medially placed of all the basilar segments. Because this segment lies posterior to the heart, the cardiac border can be outlined. This usually does not extend to the diaphragm and is seen as a semicircular density adjacent to the right side of the heart.

Lateral Basilar Segment (Fig. 8). This segment involves that portion of lung

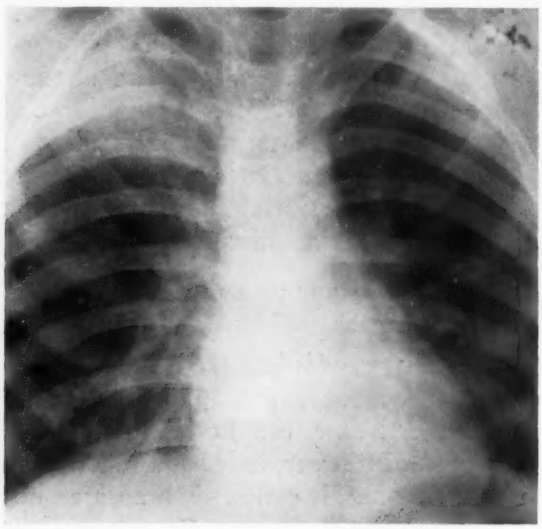

FIG. 2. Right upper lobe. Posterior segment.

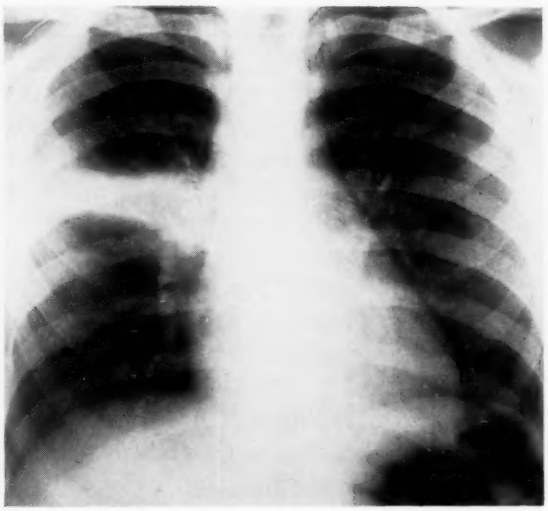

FIG. 3. Right upper lobe. Anterior segment.

above the distribution of the anterior basilar segment. It does not reach the right costophrenic sulcus. The diaphragm is well outlined and there is no distortion of the hilus.

Posterior Basilar Segment (Fig. 9). The infiltrate is seen as a triangular density with its base on the diaphragm; it extends below the diaphragmatic margin. The cardiac margin is clearly seen. It is a larger segment than the medial basilar segment.

Anterior Basilar Segment (Fig. 10). This

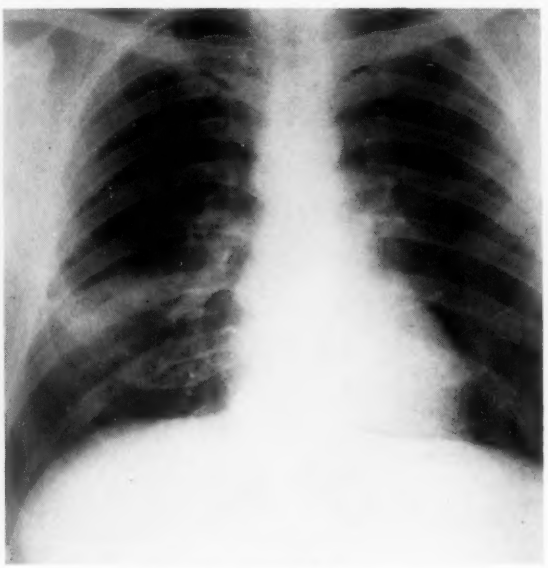

FIG. 4. Right middle lobe. Lateral segment.

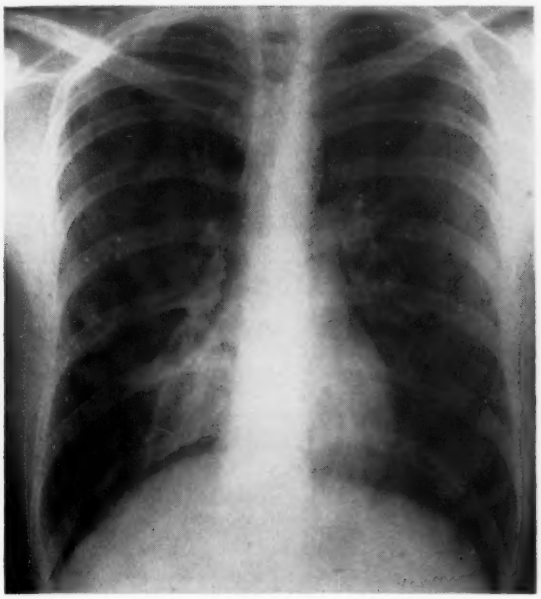

Fig. 5. Right middle lobe. Medial segment.

Fig. 7. Right lower lobe. Medial basilar segment.

segment, when involved, reveals a density extending into the right lateral costophrenic sulcus. The diaphragmatic margin is obliterated at its lateral half because the segment is anterior in position.

LEFT UPPER LOBE

Apical Posterior Segment (Fig. 11). The infiltration extends into the medial and upper portions of the lobe. It fuses with the left superior mediastinum and extends to the apical pleural line.

Anterior Segment (Fig. 12). This is a poorly defined infiltration on all borders extending into the lateral retro- and infraclavicular areas. It is difficult at times to differentiate from the superior segment of the left lower lobe. When the anterior segment is involved, however, it will usually

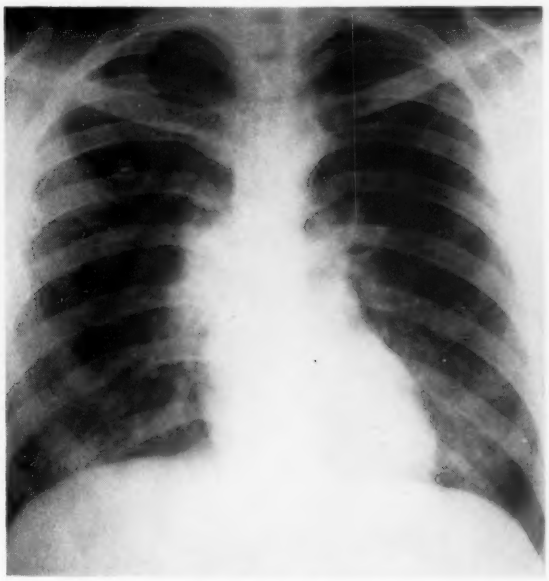

Fig. 6. Right lower lobe. Superior segment.

Fig. 8. Right lower lobe. Lateral basilar segment.

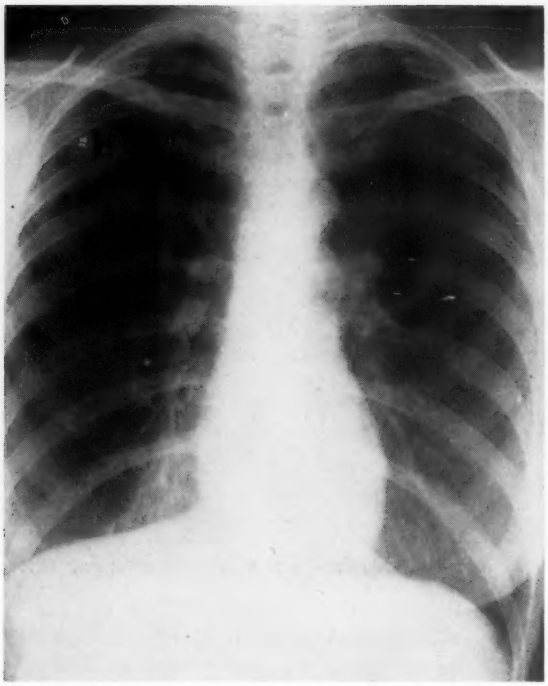

Fig. 9. Right lower lobe. Posterior basilar segment.

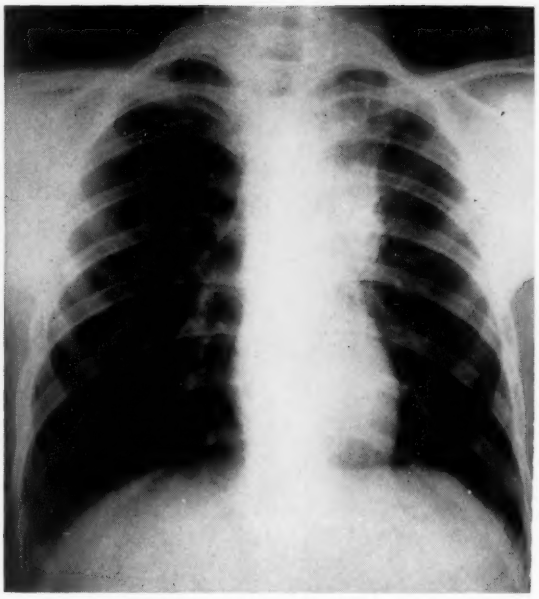

Fig. 11. Left upper lobe. Apical posterior segment.

blend with, and obliterate the superior pole of the left hilus. The superior segment of the left lower lobe does not do this because it is behind the hilus (hilar shadow sign).

Superior Lingular Segment (Fig. 13). This infiltration blends with the superior portion of the left cardiac border and it extends both laterally and inferiorly. Its upper margin is poorly defined.

Inferior Lingular Segment (Fig. 14). This segment blends with the middle and lower portions of the left cardiac margin, and may extend to the mid-portion of the left diaphragm.

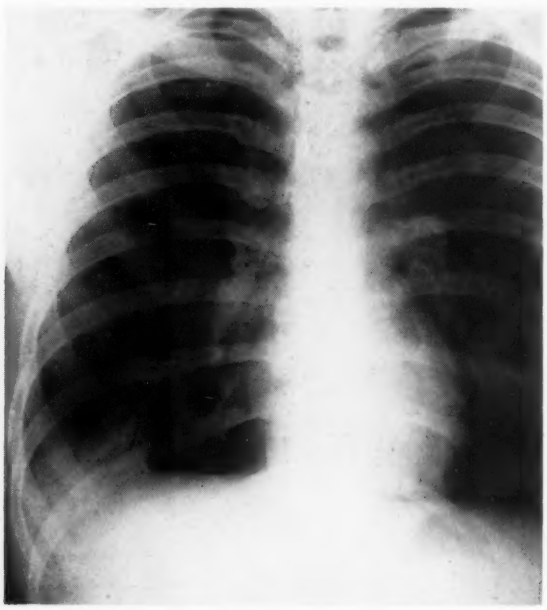

Fig. 10. Right lower lobe. Anterior basilar segment.

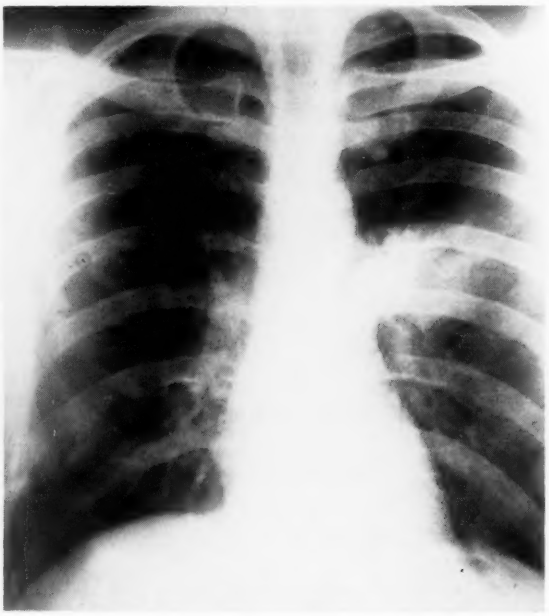

Fig. 12. Left upper lobe. Anterior segment.

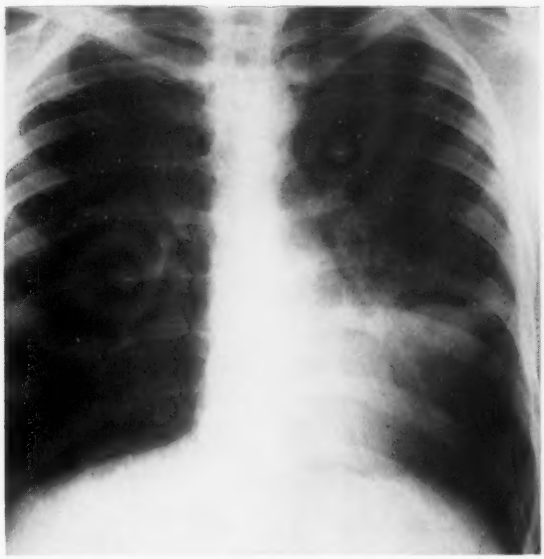

Fig. 13. Left upper lobe. Superior lingular segment.

Fig. 15. Left lower lobe. Superior segment.

LEFT LOWER LOBE

Superior Segment (Fig. 15). The infiltrate can reach a higher level than that of the superior segment of the right lower lobe. The cardiac margin and the hilar margin are well outlined. The infiltration does not reach the lateral chest wall.

Posterior Basilar Segment (Fig. 16). This infiltrate is confined chiefly to the area behind the left heart shadow and is seen only when the roentgenogram is properly exposed. This has been termed "retrocardiac pneumonitis."

Lateral Basilar Segment (Fig. 17). The infiltration extends from the left cardiac margin out to the left costophrenic sulcus. It can extend below the diaphragm but because it is posterior, the heart and diaphragm are clearly outlined.

Fig. 14. Left upper lobe. Inferior lingular segment.

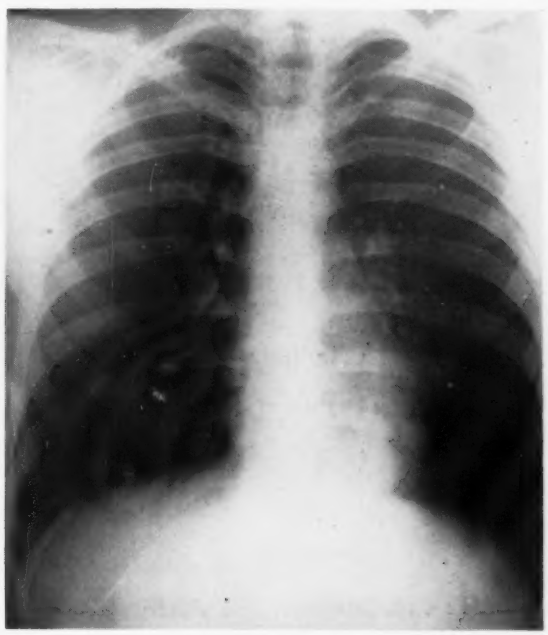

Fig. 16. Left lower lobe. Posterior basilar segment.

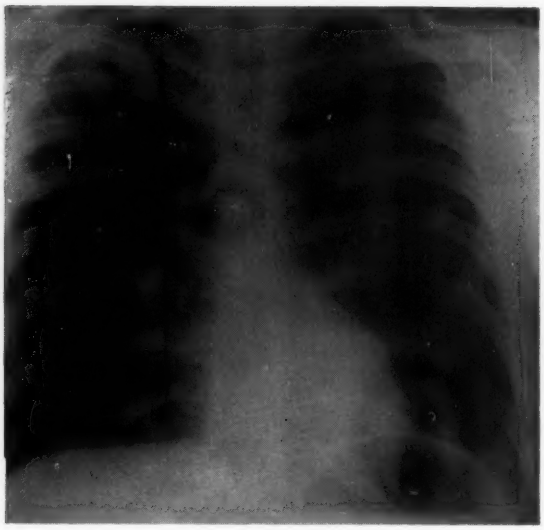

Fig. 17. Left lower lobe. Lateral basilar segment.

Anteromedial Basilar Segment (Fig. 18). The most important characteristic of an infiltration in this segment is that the lateral half of the diaphragm is obscured. It occupies almost the same position on the posteroanterior roentgenogram as the anterior basilar segment on the right. The costophrenic sulcus may or may not be involved.

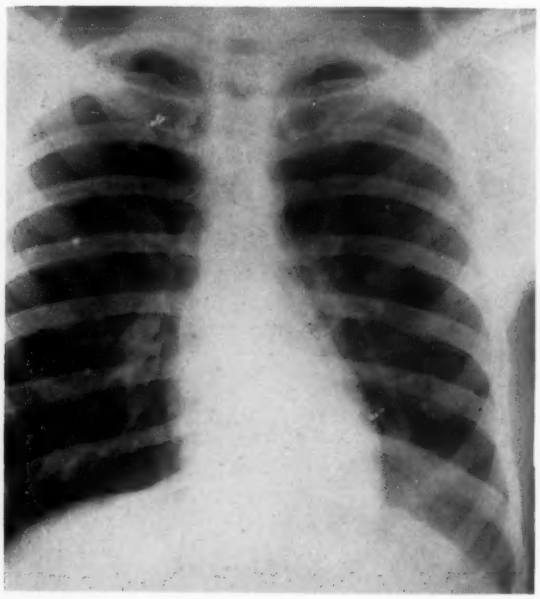

Fig. 18. Left lower lobe. Anteromedial basilar segment.

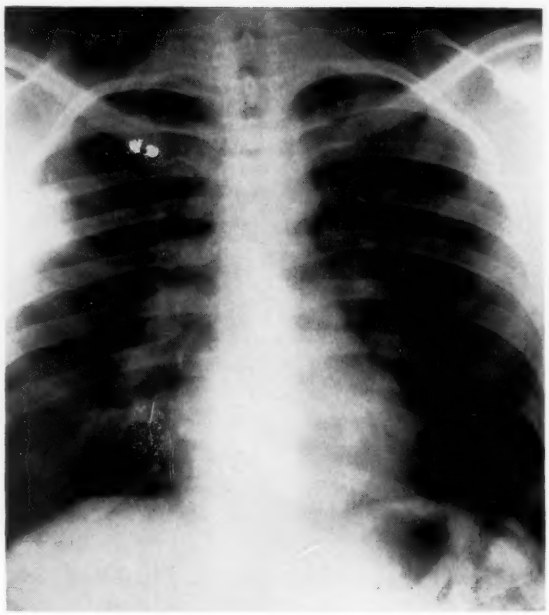

Fig. 19. Axillary (right) segment.

ANOMALOUS LOBES OR SEGMENTS

Axillary Segment (Fig. 19). The infiltrate is demonstrated by a triangular or rounded shadow located laterally with a broad base at the lateral pleura. It represents the right or left anomalous subdivisions of the anterior and posterior segments.

Inferior Accessory or "Cardiac" Lobe (Fig. 20). This segment occupies the right

Fig. 20. Inferior accessory (cardiac) lobe.

cardiophrenic angle and is sharply outlined laterally by its separate fissure. It blends with the diaphragm in its inferior margin. Usually the cardiac margin is sharply outlined.

Azygos Lobe (Fig. 21). An infiltration of this readily recognizable lobe is sharply outlined laterally by its own separate fissure.

De've's Accessory Lobe (Fig. 22). An infiltrate here is seen as an apical subdivision of the superior segment of either lower lobe and is separated from the remainder of the lower lobe by its own fissure which lies more inferiorly than the horizontal fissure on the right.

Fig. 22. De've's accessory lobe.

DISCUSSION

When a segment is involved by a disease process and little distortion is present, the distribution is generally characteristic enough that the segment involved can be determined on the posteroanterior roentgenogram. In many cases, even small patchy infiltrates can be localized to the segment involved when one of the characteristics of a specific segment is present.

Utilizing the principles described by previous authors, the vast majority of pneumonic infiltrations observed in this study were localized to a single bronchopulmonary segment, or segments, if the involvement was multisegmental. Further applying these principles, the authors have noted changes in the appearance of the hilar shadow with certain infiltrations. Diseases involving the anterior segment obscure the hilar shadow since they are contiguous. Infiltrations lying in the superior segment of the lower lobe also overlie the hilar shadow but do not obscure the definition of the individual structures, since the infiltration is posterior.

Fig. 21. Azygos lobe.

Some variation was noted in the appearance of the segmental infiltrates from case to case due to incomplete involvement of the given segment of the pneumonia, variation in the size of segments, and the degree of segmental overlapping. Other changes were occasionally affected by atelectasis, emphysema, fibrosis, fluid and diaphragmatic position. The diagrams presented in this report represent an average of the most common appearance in the 4,500 cases observed.

SUMMARY

1. A description of segmental pneumonic infiltration is presented together with roentgenographic reproductions and diagrams representative of the involvement

observed in each of the bronchopulmonary segments.

2. The authors demonstrate some variance in appearance of the bronchopulmonary segments compared with earlier descriptions. They are of the opinion that there is less anatomic distortion with acute pneumonia than with other pulmonary diseases, and feel that the diagrams accurately depict the bronchopulmonary segments.

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REFERENCES

1. BOYDEN, E. A. Symposium on lung; observations on history of bronchopulmonary segments. *Minnesota Med.*, 1955, *38*, 597–598.
2. BROCK, R. C. The Anatomy of the Bronchial Tree with Special Reference to the Surgery of Lung Abscess. Second edition. Oxford University Press, New York and London, 1954.
3. FELSON, B., and FELSON, H. Localization of intrathoracic lesions by means of postero-anterior roentgenogram; silhouette sign. *Radiology*, 1950, *55*, 363–373.
4. JACKSON, C. L. Segmental bronchi and bronchopulmonary segments. *Am. J. Surg.*, 1955, *89*, 319–323.
5. KANE, I. J. Segmental localization of pulmonary disease on postero-anterior chest roentgenogram. *Radiology*, 1952, *59*, 229–237.
6. KANE, I. J. Segmental localization of pulmonary disease; medical and surgical significance. *Am. J. Surg.*, 1955, *89*, 324–330.
7. RIGLER, L. G. Density of central shadow in diagnosis of intrathoracic lesions. *Radiology*, 1939, *32*, 316–324.
8. ROBINS, L. L., and HALE, C. H. Roentgen appearance of lobar and segmental collapse of lung; preliminary report. *Radiology*, 1945, *44*, 107–114.
9. ROBBINS, L. L., and HALE, C. H. Roentgen appearance of lobar and segmental collapse of lung; technic of examination. *Radiology*, 1945, *44*, 471–476.
10. ROBBINS, L. L., and HALE, C. H. Roentgen appearance of lobar and segmental collapse of lung; normal chest as it pertains to collapse. *Radiology*, 1945, *44*, 543–547.
11. ROBBINS, L. L., and HALE, C. H. Roentgen appearance of lobar and segmental collapse of lung; collapse of entire lung or major part thereof. *Radiology*, 1945, *45*, 23–26.
12. ROBBINS, L. L., and HALE, C. H. Roentgen appearance of lobar and segmental collapse of lung; collapse of lower lobes. *Radiology*, 1945, *45*, 120–127.
13. ROBBINS, L. L., and HALE, C. H. Roentgen appearance of lobar and segmental collapse of lung; collapse of right middle lobe. *Radiology*, 1945, *45*, 260–266.
14. ROBBINS, L. L., and HALE, C. H. Roentgen appearance of lobar and segmental collapse of lung; collapse of upper lobes. *Radiology*, 1945, *45*, 347–355.
15. TEMPLE, H. L., and EVANS, J. A. Bronchopulmonary segments. AM. J. ROENTGENOL. & RAD. THERAPY, 1950, *63*, 26–46.

MUCORMYCOSIS*

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MUCORMYCOSIS is a fungus infection caused by several different strains of Mucoraceae affecting the lungs, paranasal sinuses, central nervous system, external auditory canal, skin, and nails. It is a relatively newly recognized disease in the United States, the cerebral form being reported first in 1943,[11] and the pulmonary form in 1948.[5] The entity was first reported in 1885 by Paltauf with gastrointestinal, pulmonary, and central nervous system involvement. Many cases have been described in the foreign literature since then.

Mucoraceae, a family of common saprophytic molds, can under certain circumstances produce a rapidly fatal disease. They can be pathogenic for animals and spontaneous infections have been found in dogs, birds, cows, and pigs.[18] The lesions are similar in location and histologic characteristics to those reported in humans. The spores may be air-borne and enter the sinuses and lungs by inhalation.

Mucormycosis of major organ systems in humans has almost invariably been associated with some underlying disease process, particularly metabolic disturbances such as diabetes mellitus. These metabolic disturbances are frequently accompanied with altered susceptibility and response to infection. This probably provides the background for the development of this uncommon infection, of which there possibly is an actual increase in the number of cases.

The present paper describes 4 cases of mucormycosis, the entire experience at Yale-New Haven Medical Center. All recognized cases have occurred since 1955.

REPORT OF CASES

CASE 1. D. J. R., a seventy-two year old white male diabetic, was admitted to the hospital on December 24, 1955 with swelling of the right eye of two weeks' duration. He had a history of intermittent sinus infection of twenty years' duration. Four weeks prior to admission the symptoms recurred with pain over the paranasal sinus region. Two weeks before admission he noted progressive swelling and redness of his right eye.

Physical examination revealed an elderly white male in no acute distress. Erythema and swelling of the right periorbital region were noted in association with marked conjunctivitis, ophthalmoplegia, nonreactive pupils, and moderate proptosis. The remainder of the examination was unremarkable. Roentgenograms of the paranasal sinuses revealed a pansinusitis (Fig. 1).

The patient was placed on large doses of penicillin and streptomycin. During the first two hospital days, he did not appear acutely ill, although the temperature remained at about 102.2°F. The periorbital swelling diminished. On the third hospital day an abscess was noted over the right nasolabial fold presenting on the facial surface and nasal vestibule. Culture from the abscess revealed *M. albus*. The cellulitis of the face and right periorbital region became more extensive and the interior of the nares became covered by dark material. The clinical impression was that this was probably a cavernous sinus thrombosis associated with the micrococcus infection. Erythromycin was added to the patient's therapy. On the following day the patient's sensorium became clouded and the ala of the right nostril appeared gangrenous. On the fifth hospital day he became comatose. The nonprotein nitrogen and electrolytes were within normal limits but the fasting blood sugar was over 400 mg. per cent. The patient failed to improve and expired on the sixth hospital day.

Postmortem examination of the sinuses disclosed a thick dark red-brown purulent material in the ethmoid and sphenoid sinuses bilaterally and in the nasopharynx. The maxillary sinuses were not examined. Smears of the exudate revealed numerous gram-positive cocci, gram-negative rods, and occasional gram-posi-

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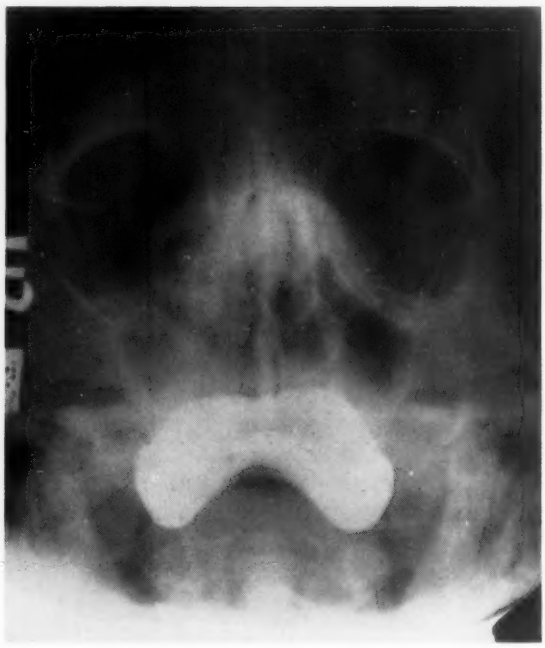

FIG. 1. Case 1. Paranasal sinus roentgenogram showing sinusitis of the frontals, ethmoids, and maxillary sinuses bilaterally. Soft tissue swelling of the right cheek, periorbital region, and nose associated with cellulitis. Clinically, abscess developed in the right nasolabial fold. Postmorten examination of sinuses revealed mucormycosis.

tive rods. Microscopic examination demonstrated an acute and chronic sinusitis of the ethmoid and sphenoid sinuses. The walls of the sinuses were thickened, edematous, and infiltrated with leukocytes. Numerous broad nonseptate branching hyphae and an occasional round to oval sporangium were seen.

The right ophthalmic vein was thrombosed. The cavernous sinuses were not thrombosed, but the internal carotid artery where it entered the cavernous sinus was occluded by a plug of homogeneous yellow material, which on smear was a purulent thrombus. In the outer wall of the artery many large branching hyphae were seen. Many of these hyphae were also present in the lumen and wall of a small vessel in the region of the pituitary. Examination of the brain revealed a moderate cerebral edema. An acute basal meningitis associated with a small amount of thick purulent exudate was noted. Many broad nonseptate branching hyphae were present. Throughout the superficial layers of the brain, especially in the region of the pons, cerebellum, and frontal cortex, many small abscesses were seen. Nonseptate branching hyphae were present in the meninges and meningeal vessels in these regions. In many sections hyphae could be seen in the vessel walls proper.

CASE II. S.M., a six and one-half year old white female, was admitted on December 12, 1956 because of drowsiness, staggering gait, tachypnea, polyuria, and polydipsia.

She was well until four months prior to admission, when she had a bout of tonsillitis which responded well to antibiotics. Two months before admission the child began losing weight and later in the month noticed onset of polyuria and polydipsia. One month before admission there was a second bout of tonsillitis with increase in severity of diabetic symtomatology. On the day of admission she became lethargic and tachypneic. Strabismus and ptosis on the left side were noticed. The patient had a bout of epistaxis, the gait became unsteady, and she appeared somewhat disoriented.

Physical examination revealed a thin child in borderline contact breathing in Kussmaul fashion. Her skin was dry with poor turgor. There was purulent sanguineous material in the left nostril, the mucosa of the pharynx was reddened and the tonsils were enlarged. Fine rales were noted at both lung bases. Neurologic examination revealed paresis of cranial nerves 3, 4, 5, 6, and 7. There were no long tract signs. Swelling in the left periorbital region was present in association with ptosis of the left lid.

On the following day the presence of bilateral Babinski and Chaddock signs was noted. Deep tendon reflexes were less active. The gross swelling on the left became more prominent with a definite bluish hue to the whole left side of the face. At this time cavernous sinus thrombosis was considered in association with sinusitis. Roentgenograms of the sinuses showed left maxillary, left ethmoid, bilateral sphenoid, and probable frontal sinusitis. Retinal artery thrombosis was noted on the left and a right hemiparesis became evident. During the day the patient's left face became more swollen and ecchymotic. Later, on the second hospital day, a radical frontal-ethmoid sphenoidectomy was performed. The mucosa of the left ethmoid cells appeared dark and congested and some cells contained pus. The sphenoid sinus was entered and found to contain thin hemorrhagic fluid. The left frontal sinus did not appear involved. There was no gross involvement of the periorbital space. The left

turbinates were necrotic. The patient's condition slowly deteriorated. Throughout the course insulin, fluids, electrolytes, and high doses of penicillin were administered as indicated. The pulse became thready, urine flow decreased and the patient expired approximately fifty hours following admission.

Postmortem examination of the nose showed infarction of the turbinates, which were discolored brown-black and hemorrhagic. Microscopic examination of the ethmoid epithelium showed necrosis. The subepithelial tissue was infiltrated by vegetative mycelia of Mucoraceae. In the spaces between the turbinates the aerial reproductive mycelia were seen.

The left internal carotid in the region of the cavernous sinus was distended by thrombus. Mycelia were present throughout the artery wall and within the thrombus. The pituitary appeared hemorrhagic. Fungi were present in the tissues of the anterior lobe. Sections of the eye revealed an acute necrosis of the retina. In the fatty tissues of the orbit, mycelia were seen in addition to thrombi and fat necrosis. The nerves and extraocular muscles were densely infiltrated by the fungus. Examination of the brain revealed an extensive region of softening and necrosis involving the inferior portion of the frontal and temporal lobes on the left. A small zone of softening was noted on the left side of the pons and left cerebellum. Focal meningitis in association with thrombosis of small vessels and mycelia throughout the tissue including the vessel walls was found.

Case III. J.S.C., a fifty year old white female, was brought to the emergency room because she was unresponsive. The history prior to admission is not clearly defined. Approximately twenty-five years previously, the patient was found to have diabetes mellitus.

During the past three years, she had been treated intermittently for infection of her right foot. Two weeks prior to admission the infection reappeared. Twenty-four hours before she was admitted, she became disoriented and slowly unresponsive and obtunded.

Physical examination revealed nonreactive pupils. A few cracking basilar rales were heard bilaterally. An ulceration was noted on the plantar surface of the right foot. The cranial nerves could not be tested. There was no Babinski or Hoffmann sign. Blood sugar on admission was 960 mg. per cent and the remainder of the studies was consistent with diabetic acidosis. She was started on an intensive therapeutic regimen including antibiotics. On the following day moderate edema of the orbital sclera was present bilaterally. External ocular movements were performed with only slight limitation on the right. On the third day following admission the patient was oriented and had shown a good chemical response to treatment although the temperature persisted at about 103° F. Roentgenograms of the chest showed an infiltration in the right lower lobe (Fig. 3). On the following day the right maxillary region was noted to be tender, edematous, and associated with periorbital edema. A small ulceration was noted inside the right alveolar ridge and hard palate. Roentgenograms obtained on the fourth hospital day revealed pansinusitis (Fig. 2). The cellulitis of the right maxillary region was thought to represent a bacterial infection and the patient was started on heavy doses of penicillin and streptomycin. At about this time cultures of the urine and foot revealed *Candida albicans*. Several whitish plaques were noted on the cheek and hard palate. This was presumed to represent moniliasis and topical amphotericin was started. By the seventh day definite ophthalmoplegia was noted. On the eighth day a right antro-oral

Fig. 2. Case III. Initial paranasal sinus roentgenogram showing sinusitis with involvement of the frontals, ethmoids, and maxillary sinuses bilaterally. On the fifteenth hospital day, a right radical antrotomy revealed mucormycosis.

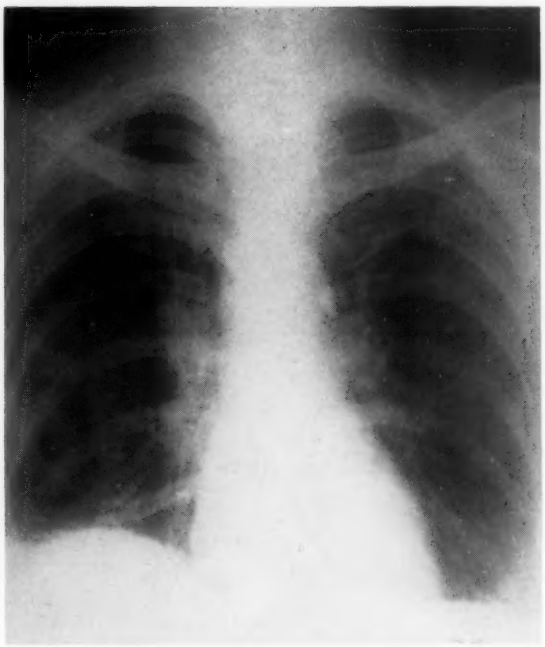

Fig. 3. Case III. Initial chest roentgenogram (December 2, 1957) showing infiltration in the right lower lobe in association with elevation of right diaphragm and pleural reaction. Two days later bronchoscopy revealed fungi of the Mucoraceae family.

fistula was discovered. This was enlarged and iodoform packing was inserted. A radical antrotomy was performed on the fifteenth day. There was marked necrosis of the anterior wall of the maxillary sinus. Tissue smears showed fungi of the Mucoraceae family. Cultures, however, revealed *A. aerogenes*, *Staphlococci*, and *Streptococci*. Roentgenograms of the chest demonstrated an abscess of the right lower lobe and an infiltration of the right upper lobe. Two days later additional infiltration in the left lower lobe was present (Fig. 4). Bronchoscopy yielded a specimen in which fungi of the Mucoraceae family were present. The area of erosion on the hard palate progressed rapidly and a new lesion appeared in the left posterior hard palate. The necrosis on the right extended into the antrum and into the subcutaneous tissues of the right cheek. The patient showed progressive deterioration and expired on the forty-first hospital day.

Postmortem examination revealed pulmonary infarction in the right lower lobe. Cross section of the related vessel showed diminution of the lumen with thickening of the wall and presence of purulent material. An extensive area of infiltration was present in the left lower lobe. In the basilar portion of the right lower lobe, two abscesses were noted. The abscesses contained fungi and necrotic cells. The arteries supplying this area as well as the smaller branches contained fresh thrombi in which there were many fungus elements, which could also be seen in the walls of the vessels. In the infarcted area many nonseptate branching hyphae could be seen. Sections of the left lower lobe revealed an acute inflammatory reaction with many leukocytes, bacteria, and fungi.

Case IV. C.C., a thirty nine year old Negro, was admitted on August 9, 1958 with pain in the right eye of two days' duration. There was gradual onset of dull steady nonradiating pain in the right frontal region, which soon involved the periorbital area. Numbness of the right forehead and scalp was also present. The eyelid gradually began to droop until the eye was completely closed. One day prior to admission he noticed proptosis. He could still see by manually lifting his eyelid. On the morning of admission he discovered that he could not see at all with his right eye.

Diabetes mellitus was first discovered fifteen years prior to admission associated with weight loss, polydipsia, and polyuria. Seven to nine years previously he was hospitalized three times for regulation of his diabetes, and during the past three to four years, he had two to three hypoglycemic episodes. He did not take his insulin regularly and was on no special diet.

Physical examination revealed amaurosis of the right eye, bilateral retinal exudates, and capillary angiomas bilaterally. Proptosis, complete ophthalmoplegia, and ptosis of the right eye were present. The seventh to twelfth cranial nerves were intact. Roentgenograms of the paranasal sinuses demonstrated clouding of the right ethmoids and swelling of the turbinates. The presumptive diagnosis was retrobulbar neuritis; the possibility of mucormycosis was raised.

Heavy antibiotic therapy was begun. By the second hospital day thrombosis of the ophthalmic artery developed. At this time it was decided to perform a biopsy of the right inferior turbinate and a right external ethmoidectomy to confirm the clinical impression of mucormycosis. Examination under anesthesia revealed a hemorrhagic nasal discharge. The whole right lateral wall of the nose including the middle turbinate and the anterior part of the inferior

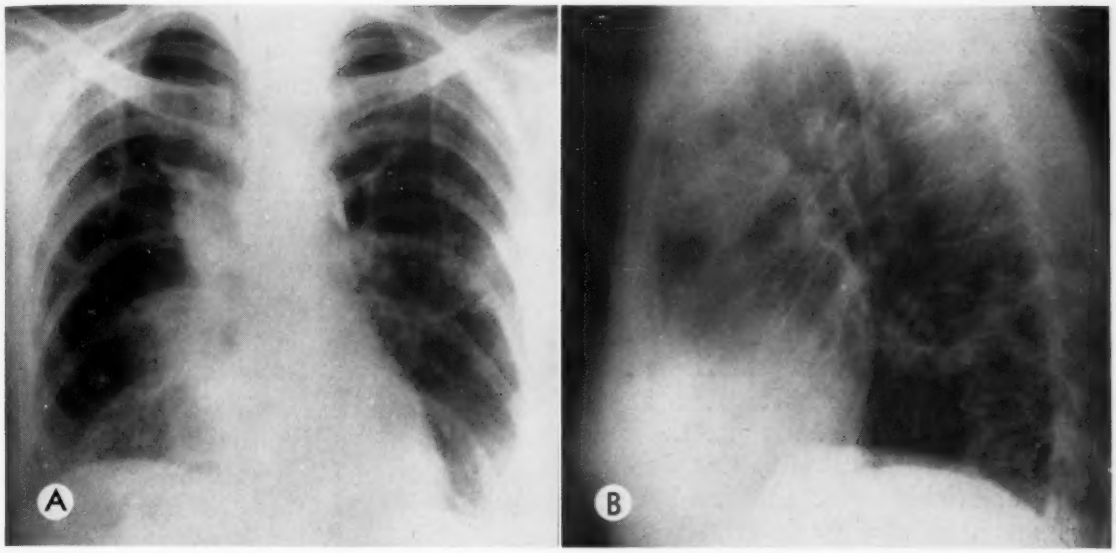

Fig. 4. Case III. (*A* and *B*) Repeat posteroanterior and lateral chest roentgenograms (December 18, 1957) demonstrating infiltration of the anterior segment of the right upper lobe, infiltration and abscess cavity formation in the right lower lobe, and minimal infiltration in the left lower lobe. Postmortem examination revealed infarction of the right lower lobe with abscesses containing fungi. The right upper and left lower lobes also showed mucormycosis.

turbinate was found to be infarcted. A radical fronto-ethmoido-sphenoidal sinusotomy and a biopsy of the right inferior turbinate were performed. Hemorrhagic fluid was present in the ethmoids; the sphenoids did not appear involved. The pathology report on the submitted specimens was consistent with mucormycosis. The patient's condition rapidly deteriorated and on the third hospital day a left hemiplegia developed. The patient expired on the fourth day.

Postmortem examination of the nasal septum, right superior and middle turbinates, right maxillary sinus mucosa, and left superior turbinate revealed all tissues from the right side to contain nonseptate hyphae in blood vessel walls and lumina where they were associated with thrombosis. The retrobulbar tissue and ocular bulbi showed infiltration of vessels, nerves, muscles, and interstitial fat by nonseptate hyphae on the right side only.

The right internal carotid artery was completely occluded by gray-yellow pultaceous material. Its wall was soft and necrotic. The left internal carotid, basilar, and vertebral arteries were free of occlusions. Sections of all components of the circle of Willis and their proximal branches showed involvement by nonseptate hyphae more marked on the right. The meninges at the base of the brain were necrotic and covered with a thin fibrinous exudate. The right frontal lobe, optic chiasm, caudate nucleus, putamen, mammillary bodies, pons, and upper medulla also showed infiltration by the fungus and thrombosis of vessels.

Cultures of the specimens obtained during the sinusotomy revealed *Rhizopus oryzae*.

DIAGNOSIS

Eumycetes (true fungi) can be separated into two groups: (1) *Mycelium lacking septation.* Phycomycetes. Family: Mucoraceae; Gen. Absidia; Gen. Rhizopus; Gen. Actinomucor; Gen. Phycomyces; Gen. Circinella; Gen. Mucor; Gen. Zygorhynchus. (2) *Mycelium with septation.* Ascomycetes.

The species comprising the family Mucoraceae are very numerous and as widespread as saprophytes on plants and animals. Molds of the genus Rhizopus frequently appear as a white fuzzy growth on bread or other starchy foods. The Mucoraceae are very common as laboratory contaminants and, because of this, the diagnosis should not be made unless there is histologic evidence of tissue invasion. The family Mucoraceae contains three clinically significant genera: Rhizopus, Mucor,

and Absidia. Of these, the most important is Rhizopus, and in those relatively few instances where the organism was identified by culture, Rhizopus has been by far the most common.

These fungi must be identified by their characteristic sporulation in culture. Here, Mucor grossly resembles Rhizopus but possesses no stolons, the sporangiophores arise on any point of the much branched aerial mycelium, and the columella is round. Rhizopus possesses stolons. Clusters of sporangiophores and rhizoids form at the same point on the stolons, and the columella is hemispherical. Absidia possesses stolons and richly branched rhizoids. Sporangiophores are straight, internodal and in clusters of two to five. The columellae are hemispheric, conic, or mammiform.

The diagnosis in most reported instances has been made postmortem by the appearance of the fungi on tissue section. These fungi, however, cannot be differentiated by their appearance in tissue but must be identified by their characteristic sporulation in culture. In tissue the fungi of this group possess wide hyphae (6–50μ) which are nonseptate (coenocytic). The diagnosis of mucormycosis on tissue section has usually been made on what was felt to be the unusual affinity for vessels with associated thrombosis and infarction.

Definitive diagnosis depends primarily on clinical suspicion. This makes it possible to culture the organisms prior to postmortem preservation of tissue. The predisposing disease entities and medications should raise suspicions with the onset of an infectious process, and, in those instances of paranasal and cerebral involvement, the clinical appearance, particularly the presence of infarcted tissue in the paranasal area and the roentgenographic evidence of sinusitis, should be very suggestive.

Pulmonary mucormycosis may not present a characteristic clinical picture. The onset may be insidious, or the symptoms may suggest pulmonary infarction. Pulmonary infarction on some occasions may present clinically with the sudden onset of chest pain and pleural friction rub.

ROENTGENOGRAPHIC FINDINGS

The roentgenographic findings have not been specific. Paranasal sinus involvement has been manifest as clouding of the sinuses and thickened mucoperiosteal membrane. No fluid levels were noted in the present group. The relatively unimpressive findings on roentgenograms have been in marked contrast to the toxic condition of the patient.

The pulmonary involvement is manifest as a bronchitis and lobular pneumonitis. Necrosis and abscess formation may take place. The areas of consolidation fail to respond to usual therapy. Infarction is usually not distinguished as such, as contrasted to the lobular pneumonia.

Gastrointestinal involvement does not necessitate predisposing diseases or medications nor does it have any distinguishing clinical features.

TREATMENT

No specific treatment is known. Treatment consists primarily of management of the underlying disease, usually diabetes mellitus. Drugs such as antileukemic agents, cortisone, etc., should not be used as there is evidence to indicate that these facilitate initiation and spread of the fungus infection (see below). Drainage of the paranasal sinuses has been utilized but its effectiveness in the control of the disease is questionable. In 2 of the reported cases of paranasal sinus involvement with recovery,[2,13] desensitization to autogenous vaccine and iodide therapy were employed, but how effective these were cannot be determined. Amphoterocin-B, a fungicide, was used in one of the present cases with no significant response.

DISCUSSION

Although generally referred to as mucormycosis, in practically all reported cases and the one reported here in which the fungus was identified by culture, the species Rhizopus has been obtained. The term mucormycosis, however, could very well be used to identify the family Mucoraceae. In only one of our cases (Case IV) was the organism

successfully cultured, and this revealed *Rhizopus oryzae*. In Case III the organisms could be visualized in the bronchial aspirate and tissues from the paranasal sinuses, but attempts to culture the fungus were not successful. The diagnosis in the first 2 cases was established postmortem and inability to obtain material suitable for culture made specific identification of the organism impossible. *Rhizopus oryzae* has been obtained from a case of cerebral mucormycosis,[6] and *Rhizopus arrhyzus* has been reported in paranasal sinus and orbital involvement.[2,13] Some cases of pulmonary mucormycosis have been reported in which the diagnosis was based on culture of the organism from sputum. This alone without evidence of tissue invasion is not sufficient to establish the diagnosis since the Mucoraceae are common contaminants.

Most reported cases of mucormycosis have had some underlying disease. Dwyer and Changus[8] reported one case and reviewed 16 other reported cases of paranasal sinus and cerebral involvement. Table I shows the distribution of the underlying processes.

Stefanini and Allegra[19] reported a case of pulmonary mucormycosis associated with leukemia treated with ACTH, predisone and antibiotics, and reviews 21 previously reported cases of pulmonary mucormycosis with similar associated conditions in 10 of the cases (Table II).

Uncontrolled diabetes, leukemia, antileukemic drugs, some antibiotics, and cortisone appear to render the patient susceptible to invasion. This is supported by experimental data of other investigators who have shown that there is increased susceptibility to pulmonary spread of Rhizopus in rabbits with alloxan diabetes,[7,9,17] and that cortisone promotes spreading of fungi of the Mucoraceae family in the animal body.[4] Baker *et al.*,[3] however, report 2 cases and review the 3 other reported cases of gastrointestinal mucormycosis in which there was no instance of prior diabetes mellitus or leukemia. This is in contrast to the usual clinical background in cerebral and pulmonary mucormycosis. The cases reported in the present paper were all characterized by having diabetes mellitus, in 2 cases poorly controlled. Large doses of antibiotics had been administered after the onset of clinical symptoms. These factors probably influenced the course of the disease.

All age groups, from five months to seventy-five years, have been reported to be involved. Sex and race have been equally susceptible and there is no known occupational predisposition.

There are several forms of involvement including cutaneous, ocular,[21] cerebral,[6,10,11,12,14,15] pulmonary,[1,5,21] gastrointestinal,[3,16] and disseminated. Pulmonary mucormycosis is of two types:[2] (a) primary and (b) hematogenous. In the primary form the fungus grows in the bronchi, involves hilar tissue, then invades arteries and veins to cause thrombosis and infarction. Central nervous system disease is manifest by

Table I

Underlying Disease Entity	No. of Cases of Paranasal and Cerebral Mucormycosis
Diabetes mellitus	11
Nephritis	2
Dehydration and marasmus	1
Liver abscess, postcholecystectomy	1
Leukemia under 6-mercaptopurine and cortisone therapy	1
Cirrhosis and penicillin therapy	1

(From Dwyer, G. K., and Changus, G. W. *A.M.A. Arch. Otolaryng.*, 1958, *67*, 619–623.)

Table II

Underlying Disease Entity	No. of Cases of Pulmonary Mucormycosis
Leukemia (including 2 cases treated with 6-mercaptopurine or ACTH or both and antibiotics)	6
Leukemia, treatment not specified	3
Multiple myeloma treated with urethane, cortisone, and roentgen-ray therapy	1

(From Stefanini, M., and Allegra, S. *New England J. Med.*, 1957, *256*, 1026–1030.)

the triad: (1) uncontrollable diabetes, (2) orbital infection, and (3) meningoencephalitis. Central nervous system involvement is usually preceded by paranasal sinus disease and the fungus appears to spread via blood vessels, especially those about the nerves, into periorbital tissues, venous sinuses, and finally into the brain.

The infection is characterized by acute inflammation and thrombosis caused by invasion of blood vessel walls and lumina by the fungus. Infarcts are characteristic of the disease and contribute to the appearance of pulmonary infiltrates as demonstrated on roentgenograms. The extensive pulmonary pathology noted in Case III was due primarily to changes associated with infarction. Clinically, infarction has been manifest, as in the cases reported above, by hemorrhage and necrosis involving the nasal turbinates and soft tissues of the cheeks. In cerebral mucormycosis thrombosis of the internal carotid artery is common. This finding was noted in Cases I, II, and IV. Other thromboses included the right ophthalmic vein in Case I, the retinal artery in Case II, the ophthalmic artery in Case IV, and the peripheral pulmonary arteries in Case III. The affinity for vessels and the rapid and usually fatal course are unusual among fungus infections.

Practically all reported cases, and all of those reported in the present paper, have been fatal. A few cases[2,13] of isolated paranasal sinus involvement have recovered. Dwyer and Changus[8] designated paranasal sinus involvement as rhinomucormycosis to emphasize the possible controllable portion of the entity. Pulmonary and cerebral disease has been invariably fatal. The diagnosis is rarely established before death since it is a relatively uncommon entity and infrequently considered in the differential diagnosis. In the present series the diagnosis was established in the last 2 cases prior to death. In Case III the organism was identified by means of bronchoscopic aspiration, and in Case IV by biopsy of the nasal turbinate and sinus mucosa. Cases of pulmonary mucormycosis with survival have been reported but, as stated above, these have been based on sputum culture alone.

SUMMARY

Four cases of mucormycosis, all fatal, are reported involving patients aged six and one-half, thirty-nine, fifty and seventy-two years. Mucormycosis is a rapidly fatal disease characterized by acute inflammation and vascular thrombosis, caused by invasion of the walls and lumina of blood vessels by the fungus. The reported cases have almost invariably been associated with some underlying disease, usually diabetes mellitus but including leukemia under treatment, nephritis, and cirrhosis. The 4 cases in our series had diabetes mellitus. The clinical appearance of paranasal and cerebral involvement is characteristic although this does not appear to be true of involvement of other organ systems.

The roentgen findings are not diagnostic. Paranasal sinus disease is manifest by clouding and thickened mucoperiosteum. Possibly the absence of fluid levels and the relatively unimpressive extent of the paranasal sinus involvement as compared to the toxic state of the patient may be characteristic. Pulmonary involvement is manifest as a lobular pneumonia with abscess formation and lack of response to therapy. Infarctions are not recognized as such.

Although the roentgenographic changes are not characteristic, awareness of the entity and its association with predisposing metabolic disturbances may make it possible to consider the diagnosis while the disease is still in its controllable stage.

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REFERENCES

1. BAKER, R. D. Pulmonary mucormycosis. *Am. J. Path.*, 1956, *32*, 287–313.
2. BAKER, R. D. Mucormycosis—new disease? *J.A.M.A.*, 1957, *163*, 805–808.
3. BAKER, R. D., BASSERT, D. E., and FERRINGTON, E. Mucormycosis of digestive tract. *A.M.A. Arch. Path.*, 1957, *63*, 176–182.

4. Baker, R. D., Schofield, R. A., Elder, T. D., and Spoto, A. P., Jr. Alloxan diabetes and cortisone as modifying factors in experimental mucormycosis (Rhizopus infection). *Fed. Proc.*, 1956, *15*, 506–507.
5. Baker, R. D., and Severance, A. O. Mucormycosis, with report of acute mycotic pneumonia. *Am. J. Path.*, 1948, *24*, 716–717.
6. Bauer, H., Ajello, L., Adams, E., and Useda Hernandez, D. Cerebral mucormycosis: pathogenesis of disease; description of fungus, Rhizopus oryzae, isolated from fatal case. *Am. J. Med.*, 1955, *18*, 822–831.
7. Bauer, H., Flanagan, J. F., and Sheldon, W. H. Experimental cerebral mucormycosis in rabbits with alloxan diabetes. *Yale J. Biol. & Med.*, 1955, *28*, 29–36.
8. Dwyer, G. K., and Changus, G. W. Rhinomucormycosis resulting in fatal cerebral mucormycosis. *A.M.A. Arch. Otolaryng.*, 1958, *67*, 619–623.
9. Elder, T. D., and Baker, R. D. Pulmonary mucormycosis in rabbits with alloxan diabetes; increased invasiveness of fungus during acute toxic phase of diabetes. *A.M.A. Arch. Path.*, 1956, *61*, 159–168.
10. Foushee, S., and Beck, W. C. Mucormycosis of central nervous system; case report. *North Carolina M. J.*, 1956, *17*, 26–31.
11. Gregory, J. E., Golden, A., and Haymaker, W. Mucormycosis of central nervous system; report of 3 cases. *Bull. Johns Hopkins Hosp.*, 1943, *73*, 405–419.
12. Gunson, H. H., and Bowden, D. H. Cerebral mucormycosis; report of case. *A.M.A. Arch. Path.*, 1955, *60*, 440–443.
13. Harris, J. S. Mucormycosis; report of case. *Pediatrics*, 1955, *16*, 857–867.
14. Kurrein, F. Cerebral mucormycosis. *J. Clin. Path.*, 1954, *7*, 141–144.
15. Martin, F. P., Lukeman, J. M., Ranson, R. F., and Geppert, L. J. Mucormycosis of central nervous system associated with thrombosis of internal carotid artery. *J. Pediat.*, 1954, *44*, 437–442.
16. Moore, M., Anderson, W. A. D., and Everett, H. H. Mucormycosis of large bowel. *Am. J. Path.*, 1949, *25*, 559–567.
17. Schofield, R. A., and Baker, R. D. Experimental mucormycosis (Rhizopus infection) in mice; failure of chronic alloxan diabetes to modify host susceptibility. *A.M.A. Arch. Path.*, 1956, *61*, 407–415.
18. Simons, R. D. G. Ph., Editor. Medical Mycology. Elsevier Press, Inc., Amsterdam, 1954.
19. Stefanini, M., and Allegra, S. Pulmonary mucormycosis in acute histiocytic leukemia. *New England J. Med.*, 1957, *256*, 1026–1030.
20. Stratemeier, W. P. Mucormycosis of central nervous system; report of case. *Arch. Neurol. & Psychiat.*, 1950, *63*, 179–180.
21. Wadsworth, J. A. C. Ocular mucormycosis; report of case. *Am. J. Ophth.*, 1951, *34*, 405–409.

EPIDEMIC PULMONARY HISTOPLASMOSIS

ROENTGENOGRAPHIC FINDINGS

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THIS is a report of the roentgenographic findings in 19 cases of epidemic histoplasmosis, due to a single source of *Histoplasma capsulatum* occurring over a span of three months. The literature will not be reviewed in detail. Two cases of acute histoplasmosis were reported by Fissel;[2] Reeves[5] reported one case of acute histoplasmosis, and the roentgen manifestations of acute histoplasmosis are mentioned by Felson.[1] Other than these articles, the radiologic literature contains a paucity of reports on acute epidemic histoplasmosis. Many excellent reviews of the various clinical manifestations of histoplasmosis have appeared in the recent radiologic literature. Among these is the review by Furculow,[3] which likewise deals with acute histoplasmosis and does not consider the findings in the chronic and healed forms of the disease such as cavitation, calcification and the presence of solitary nodules. The clinical features of histoplasmosis of the epidemic which form the basis of the present report have been reported by Wilcox, Waisbren and Martin.[6]

A group of men became infected while performing work associated with the construction of a new house on a vacant lot, in the community of Walworth, Wisconsin. They were engaged in digging ditches for water mains and sewer lines. The duration of exposure varied from one-half hour to eight hours. The incubation periods could accurately be determined and varied from seven to sixteen days. The cause of the outbreak was established by the isolation of *Histoplasma capsulatum* from 2 of the cases. The other cases were diagnosed by complement fixation tests. The general clinical pattern was characterized by the acute onset of malaise, fever, weakness and headache in 12 of the 19 cases. In 5 of the remaining 7 cases, a prodromal period marked by malaise and weakness was evident before the onset of fever and other symptoms. The 2 additional cases were marked by malaise, weakness, muscular aches and cough but without known fever or other symptoms. The fever varied between 100° F. and 104° F. and was present in all but 2 cases. Chills were frequent and diaphoresis out of proportion to the fever present was noted. Cough, pain in the chest and dyspnea were other symptoms.

ROENTGENOGRAPHIC FINDINGS

In acute epidemic histoplasmosis, the illness and the chest lesions may vary from very mild to extremely severe, depending apparently on the degree of exposure. However, one of the usual findings in epidemics is that patients have frequently been heavily exposed, resulting in severe illness. In most instances, although the illness may be quite severe and the appearance of the lesions on roentgenograms striking, recovery occurs. There were no deaths in this group.

In the acute phase, the roentgenogram is fairly characteristic. Scattered, poorly demarcated nodular infiltrations are seen throughout both lung fields with associated enlargement of the hilar lymph nodes. This varies in severity. In the extremely mild cases, only enlargement of the hilar lymph nodes may be noted. In the relatively mild cases, only a few peripheral nodules, or a minimal perihilar infiltration may be evident. The roentgenographic findings of the pulmonary lesions appear to be more pronounced a week or two after onset of clini-

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cal symptoms, apparently becoming more clearly visualized because they "harden." One of the cases revealed a small pneumothorax, which rapidly re-expanded; otherwise, the cases followed a fairly consistent pattern, depending upon the severity of the symptoms and the extent of the earlier roentgenographic findings.

Follow-up roentgenograms as long as two and one-half years after the acute phase showed no evidence of calcification in these cases. It has been stated that approximately three to five years elapses before calcification occurs.[4]

Although the diagnosis cannot be made with certainty from the roentgenograms alone, it should be suspected. A history of possible exposure to *Histoplasma capsulatum* in the soil should be highly suggestive. The diagnosis may be further corroborated by histoplasmin skin testing, complement fixation tests and lymph node biopsy. It must be remembered, however, that a positive histoplasmin skin test does not necessarily mean the presence of clinical histoplasmosis and that serologic tests (complement fixation and precipitin tests) are of additional aid in establishing the diagnosis. The latter are positive only during the acute phase and four to six weeks may elapse before the skin test or serologic tests are positive.

Histoplasma capsulatum exists in the soil in an endemic area, and the inhalation of the spores initiates the infection. The disease is not transmitted from person to person.

Histoplasmosis may be present with negative skin tests and negative complement fixation tests when the diagnosis is determined by biopsy only. Cross agglutination often occurs with blastomycosis.

DIFFERENTIAL DIAGNOSIS

Sarcoidosis. The roentgenographic appearance of sarcoidosis may resemble that of acute epidemic histoplasmosis. The patient is relatively asymptomatic except for the presence of dyspnea, if the lesions are far advanced. The pulmonary lesions and the hilar lymphadenopathy are quite similar. Serial follow-up examination usually shows little change in sarcoidosis over a short period of time (weeks), while changes are sometimes rapid in acute histoplasmosis. Serologic tests are often necessary.

Farmer's Lung. In farmer's lung, the predominant clinical finding is more or less severe dyspnea, occurring twenty-four to forty-eight hours after exposure to moldy dust. Roentgenographically, the pulmonary lesions appear as fine and rather diffuse densities, without hilar lymphadenopathy. In the progressive form, due to repeated exposure, pulmonary emphysema and fibrosis occur, with resultant persistent dyspnea.

Noninfectious Necrotizing Granulomatosis. In noninfectious necrotizing granulomatosis there is an allergic background. In destructive granulomatous lesions there is involvement of the skin, face and upper respiratory structures with eosinophilia and evidence of renal disease. The roentgen pattern is one of multiple, poorly defined, nodular infiltrates with central cavitation.

Eosinophilic pneumonopathy, tuberculosis, metastatic malignancy, Hodgkin's disease and other lymphomas, pneumoconiosis, acute diffuse interstitial pulmonary fibrosis (Hamman-Rich), pulmonary alveolar proteinosis and other fungus diseases may also have similar findings and should be considered in the differential diagnosis.

REPORT OF CASES

Case 1. (Fig. 1, *A–F*). A forty-two year old white male had been in good health until exposure. One week after exposure he noticed vague pains in the chest followed by a hard shaking chill and a temperature of 104°F. (oral). Penicillin therapy was begun at that time, and the patient was transferred to another hospital, where the laboratory findings two days later were relatively nonspecific. He was continued on penicillin and tetracycline, but in spite of this, a high spiking fever and a hard racking cough persisted. The patient's course

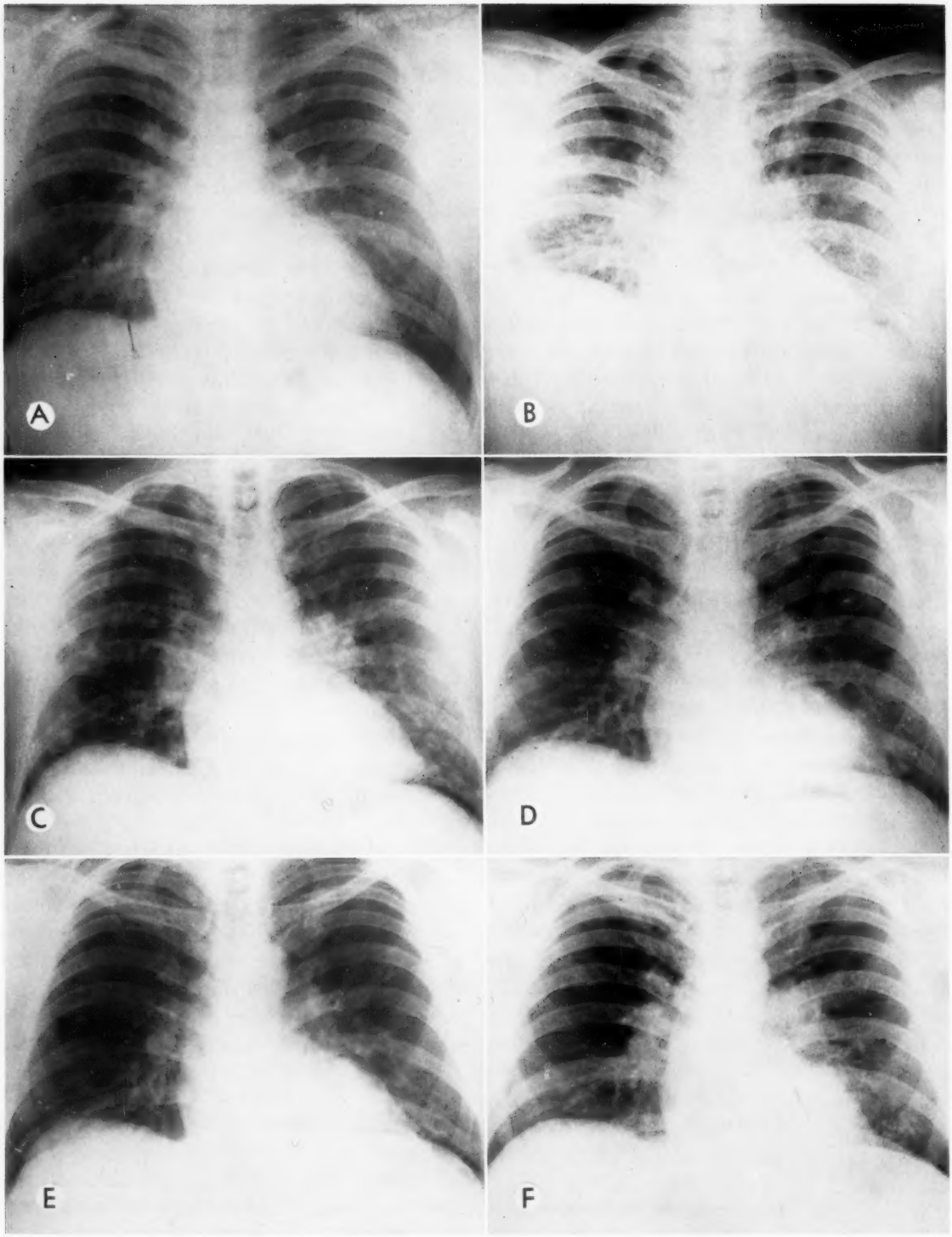

FIG. 1. Case 1. (*A*) Normal chest roentgenogram in 1949. (*B*) Chest roentgenogram seven years after *A* showing hilar lymphadenopathy and minimal diffuse infiltrates throughout both lung fields. (*C*) Roentgenogram nine days after *B* showing no change in hilar lymphadenopathy but pulmonary lesions appear more discrete. (*D*) Roentgenogram ten weeks after *C* showing slight improvement in the pulmonary lesions and slight decrease in the hilar lymphadenopathy. (*E*) Seven months after *D* only minimal residual fibrotic lesions scattered throughout both lung fields and questionable residual hilar enlargement are noted. (*F*) Roentgenogram one year after *E* (twenty-one months after *B*) showing very minimal residual pulmonary scarring and residual pulmonary hilar lymphadenopathy. No calcification is present.

improved after a positive blood culture for *Pseudomonas aeruginosa* was found and therapy with oxytetracycline, 0.5 gm. intravenously twice a day, was begun along with polymyxin B, 50 mg. intravenously daily (in one liter of 5 per cent dextrose in water). With this, there appeared to be prompt clinical improvement. The patient's wife volunteered the information that six of her husband's co-workers were in another hospital all with severe pneumonia. This suggested the possibility of histoplasmosis. A skin test was markedly positive in twenty-four hours. The complement fixation studies at this time showed titers of 1 to 16 in the mycelial phase and 1 to 64 in the yeast phase. Although the patient was improving clinically, the therapy was changed to amphotericin B, 800 mg. by mouth four times a day, and continued for three months. The patient felt chronically ill until May of 1957 (approximately nine months after the onset of illness), when he began to feel relatively normal.

Case II. The patient, a twenty year old white male, became ill with headache, malaise, chest pain and cough one week after exposure. The symptoms were mild. Approximately two and one-half weeks after exposure, the patient saw his physician, when the symptoms were subsiding. Physical examination was negative. Histoplasmin skin tests were positive on two occasions. Tuberculin and blastomycin tests were negative. Complement fixation tests revealed mycelial titer of 1 to 32, yeast titer of 1 to 64, nine weeks after the exposure. The original chest roentgenogram was not available. Roentgenograms of the chest five and twenty-one months after exposure were both negative.

Case III. A thirty-seven year old white male became ill twelve days after exposure. The illness was mild and only partially disabled him for ten days. He was not seen by a physician, until six weeks after exposure. At this time, the physical examination and chest roentgenograms were normal. The complement fixation tests to both mycelial and yeast phases were 1 to 8.

Case IV. (Fig. 2, *A–E*). A thirty-one year old white male became ill eleven days after exposure, with a temperature of 103°F., chills, malaise, headaches, sweating, and sore throat. He was seen by his physician within one day after onset of symptoms, and was treated with erythromycin with no improvement and following this, penicillin therapy was begun. A positive histoplasmin skin test was obtained four weeks after exposure, but the complement fixation tests to both yeast and mycelial phases were negative at that time. Two weeks later, the complement fixation test was positive 1 to 32 in both mycelial and yeast phases.

Case V. (Fig. 3, *A–D*). A thirty-four year old white male became ill twelve days after exposure with fever to 103°F., chills, weakness and headaches. Four weeks after exposure, a histoplasmin skin test was positive and a complement fixation test was negative for the mycelial phase and positive in a 1 to 64 dilution for the yeast phase. He made a gradual recovery marked by weakness and dyspnea.

Case VI. A forty-six year old white male first noted fever, up to 100°F. four weeks after exposure with chills and headache. Five days later profuse sweating, a hacking cough and an increase in previous symptoms occurred. The histoplasmin skin test was positive. Six weeks after exposure, complement fixation tests revealed a titer of 1 to 32 in the yeast phase. The patient recovered completely five months after the onset of illness. A roentgenogram made at the time of the acute illness was not available. Subsequent roentgenograms, five to six months after exposure and eighteen months after exposure, were negative.

Case VII. (Fig. 4, *A–C*). A thirty-three year old white male developed malaise, fever, chills, headache and muscle aches ten days after exposure. Five days later he consulted the family physician. A physical examination was negative at that time, except for scattered fine rales in the lungs. Treatment was begun with penicillin. A histoplasmin skin test was positive three weeks after exposure, and five weeks after exposure a complement fixation test in the mycelial phase was 1 to 4 and in the yeast phase 1 to 32. The patient lost ten pounds during this acute illness and continued to have weakness and cough, but returned to work six weeks after the onset of the illness.

Case VIII. (Fig. 5, *A–D* and *E–G*). A twenty year old white male two weeks after exposure developed malaise, chilly sensations and a dry nonproductive cough. He continued to work for four days, then consulted a physician. For the next ten days, he remained in the hospital

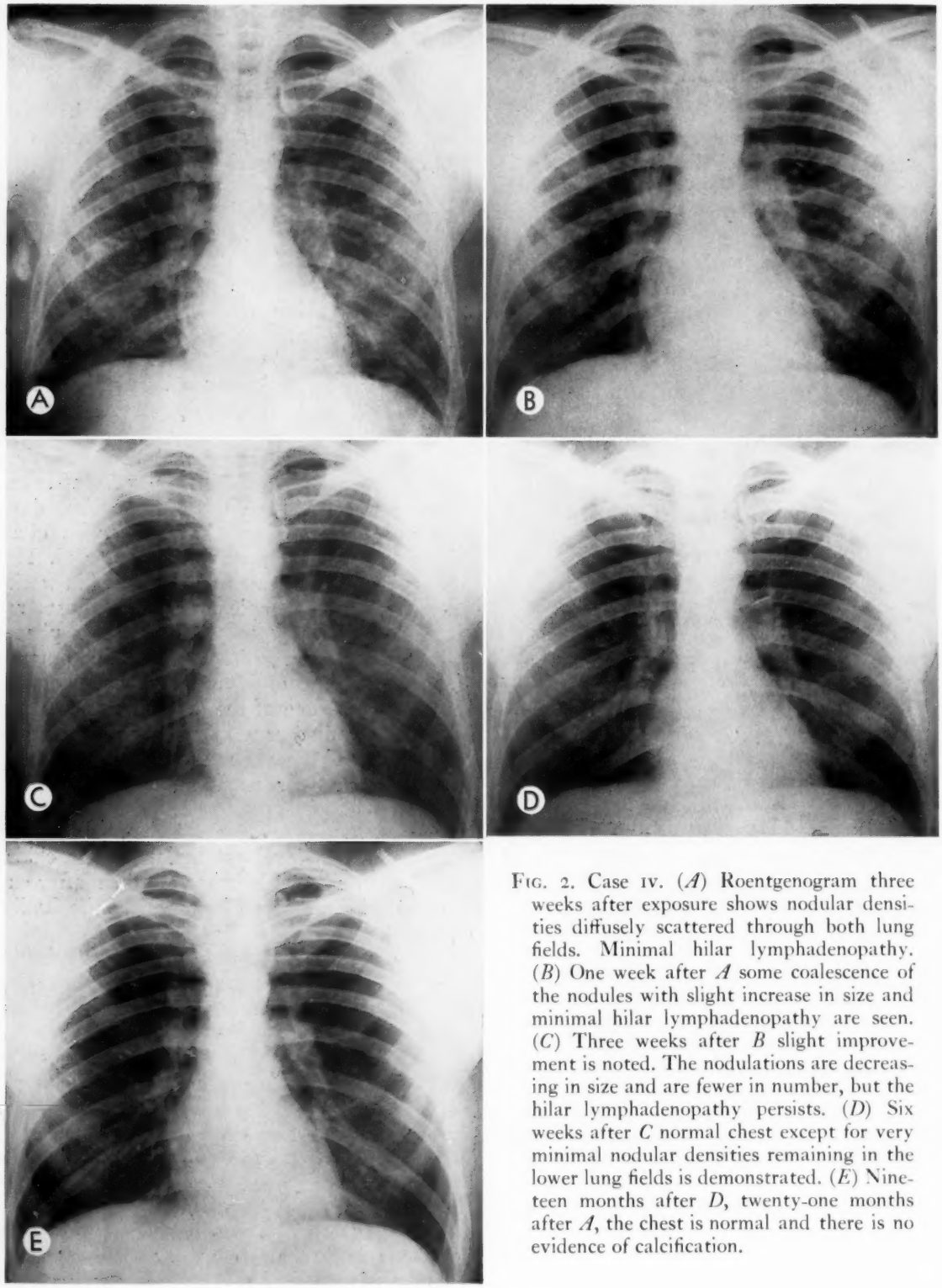

FIG. 2. Case IV. (*A*) Roentgenogram three weeks after exposure shows nodular densities diffusely scattered through both lung fields. Minimal hilar lymphadenopathy. (*B*) One week after *A* some coalescence of the nodules with slight increase in size and minimal hilar lymphadenopathy are seen. (*C*) Three weeks after *B* slight improvement is noted. The nodulations are decreasing in size and are fewer in number, but the hilar lymphadenopathy persists. (*D*) Six weeks after *C* normal chest except for very minimal nodular densities remaining in the lower lung fields is demonstrated. (*E*) Nineteen months after *D*, twenty-one months after *A*, the chest is normal and there is no evidence of calcification.

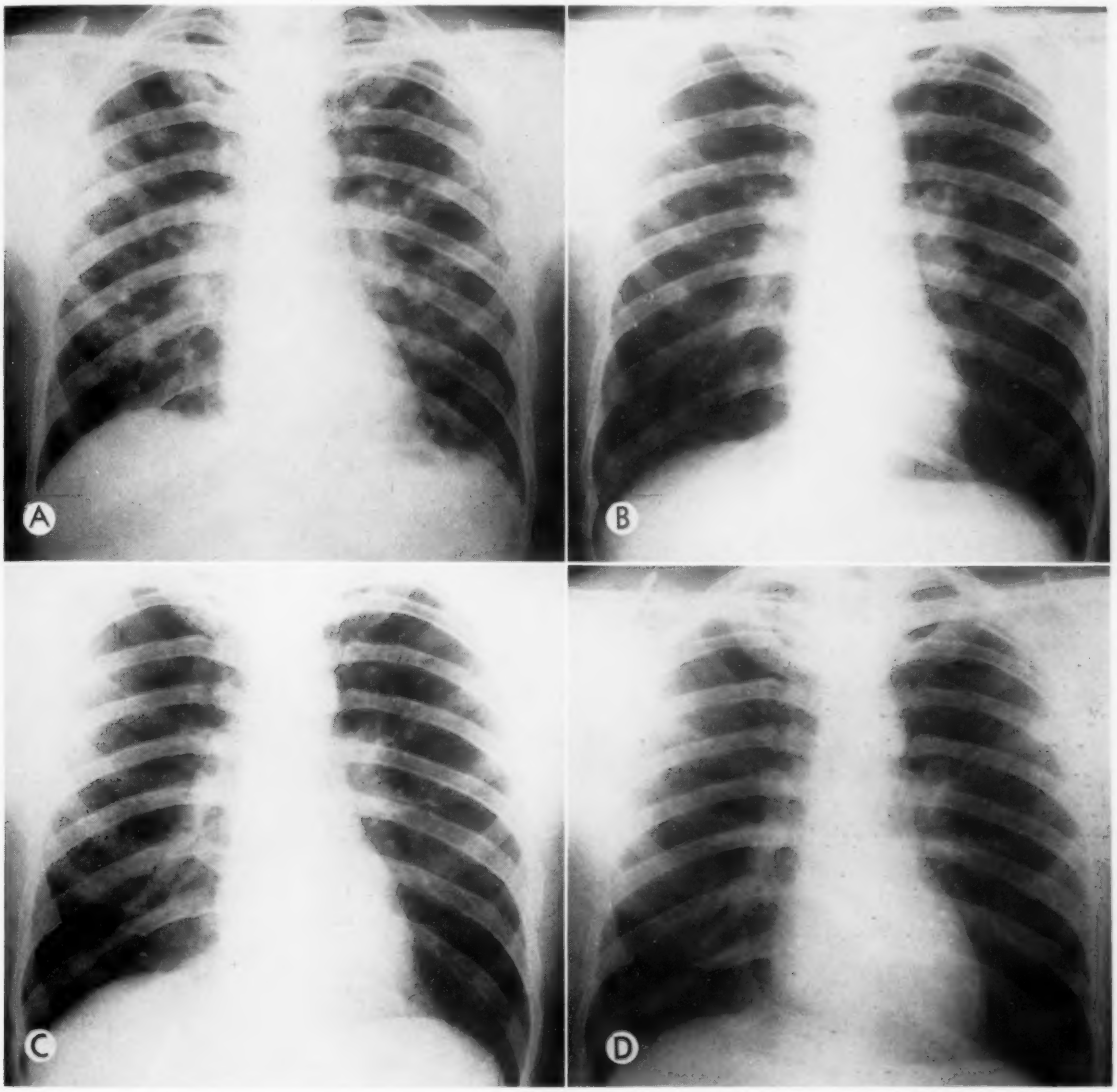

Fig. 3. Case v. (*A*) Roentgenogram four weeks after exposure shows fairly large densities scattered throughout both lung fields with some coalescence of the nodules and with moderate hilar lymphadenopathy. (*B*) Three weeks after *A* decrease in size of the pulmonary nodulations with residual hilar lymphadenopathy is noted. (*C*) Six weeks after *B* marked improvement is demonstrated with only minimal nodulations persisting. The hili are within normal limits. (*D*) Eighteen months after *C* (twenty months after *A*) the chest is normal with no residual calcification.

where he ran a temperature up to 104°F. and developed pleurisy and dyspnea. Fine rales were present in the base of the left lung field. A pericardial friction rub was heard on the left. A complement fixation test for histoplasmosis was 1 to 32 in both mycelial and yeast phases three weeks after exposure. One week later it was 1 to 128 for both antigens. The electrocardiogram was normal except for minor ST elevation (this was considered to be compatible with mild pericarditis). The patient was started on amphotericin B, 800 mg. by mouth four times a day, and after one week in the hospital, the patient was much improved and afebrile. A scalene lymph node biopsy was done with culture of the material. All cultures were positive for *Histoplasma capsulatum*, and the organism was identified in sections of the lymph node.

Case ix. A thirty-three year old white male

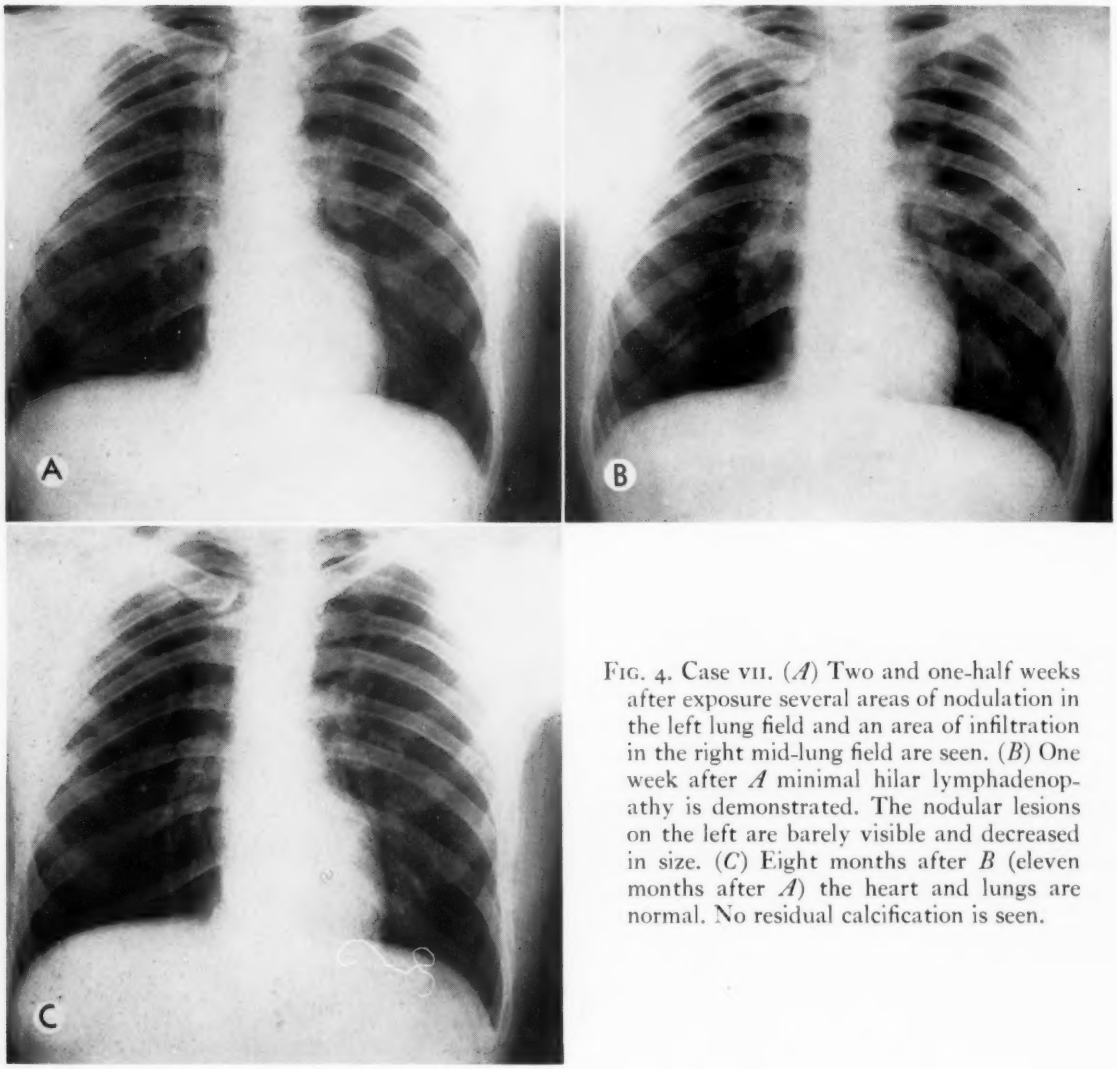

FIG. 4. Case VII. (*A*) Two and one-half weeks after exposure several areas of nodulation in the left lung field and an area of infiltration in the right mid-lung field are seen. (*B*) One week after *A* minimal hilar lymphadenopathy is demonstrated. The nodular lesions on the left are barely visible and decreased in size. (*C*) Eight months after *B* (eleven months after *A*) the heart and lungs are normal. No residual calcification is seen.

noted onset of malaise and weakness ten days after exposure. Five days later, he developed fever, shaking chills, headache, mild sore throat and cough productive of scanty white sputum, with pleuritic chest pain. Penicillin was given and on the following day, severe generalized pleuritis was noted. The pleuritis subsided when the penicillin was stopped, and symptomatic therapy instituted. Physical examination showed minimal diffuse rales in both lung fields, but was negative otherwise. The histoplasmin skin test was positive. Complement fixation tests two weeks after the exposure revealed a mycelial titer of 1 to 16 and a yeast titer of 1 to 128. Only one chest roentgenogram was available, which was taken five months after the onset of the illness and it was negative. A subsequent chest roentgenogram eighteen months after the exposure showed no evidence of calcification.

CASE X. A forty-six year old white male developed fever, chills, malaise, severe headache, cough, and pain in the chest two weeks after exposure. Three days later, he was seen by his physician and was afebrile. He had scattered expiratory wheezes, but there were no other abnormalities on physical examination. The histoplasmin skin test was positive. Three weeks after exposure, he was essentially unchanged, and his complement fixation was negative in the mycelial phase and 1 to 8 in the yeast phase. Three weeks after this study, the complement fixation was 1 to 32 in both the

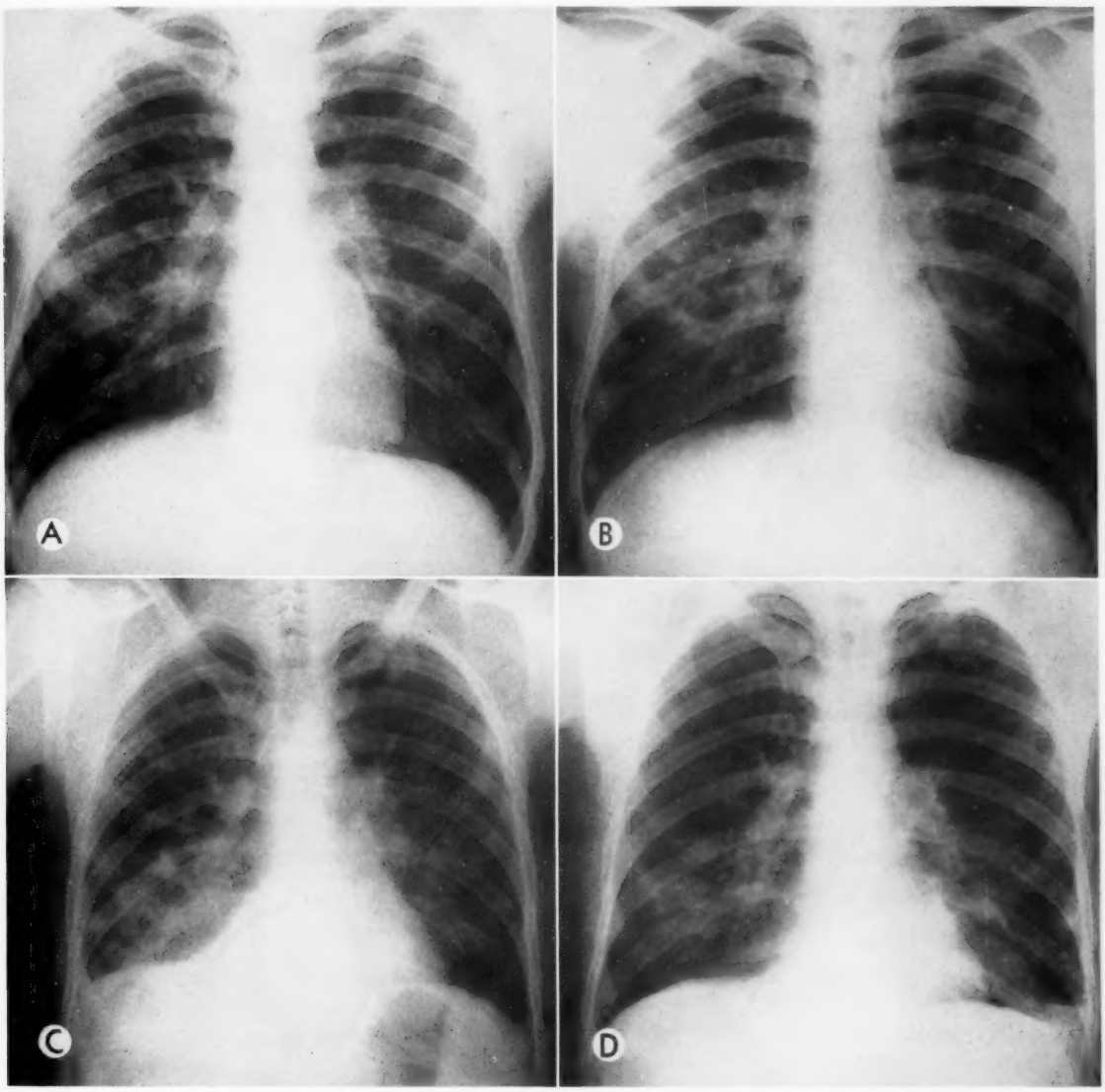

Fig. 5. Case VIII. (*A*) Roentgenogram made two and one-half weeks after exposure. Bilateral hilar lymphadenopathy and bilateral pulmonary infiltration with some nodularity are present. (*B*) Four days after *A*, increase in extent in the pulmonary nodular and infiltrative densities, particularly in right mid lung field is noted. Hilar nodularity is slightly more marked. (*C*) Four days after *B*, findings are more extensive, with coalescence in the right lower lung fields. (Roentgenogram was exposed in partial expiration.) (*D*) Nine days after *C*, marked clearing of the pulmonary lesions with some residual hilar lymphadenopathy and minimal pleural effusion in the left costophrenic sulcus are demonstrated. Small pneumothorax is seen on the left.

mycelial and the yeast phases. A chest roentgenogram was normal.

Case XI. (Fig. 6, *A–E*). A nineteen year old white male noted the onset of fever to 101°F., chills, malaise, headache, cough and scant sputum, with slight pleuritic pain twelve days after exposure. Approximately two and one-half weeks after exposure, he had some myalgia. A physical examination showed slight enlargement of the liver and a day later, steady pain in the anterior chest was noted and the patient was hospitalized. Three weeks after exposure, the histoplasmin skin test was faintly positive. The complement fixation test showed 1 to 64 titer for both mycelial and yeast phases. Six months later, the complement fixation test was 1 to 8 in the mycelial and 1 to 16 in the yeast

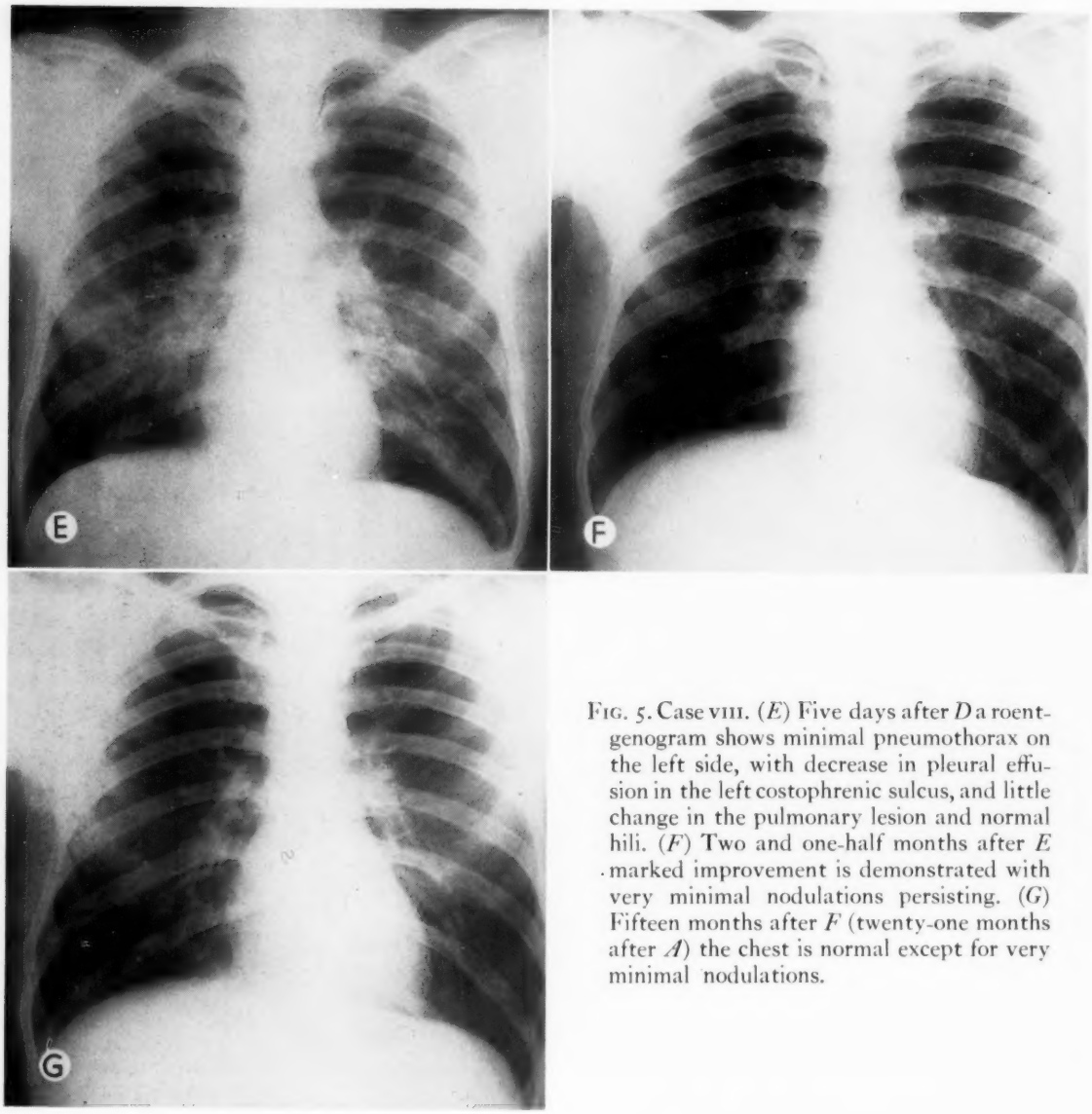

FIG. 5. Case VIII. (*E*) Five days after *D* a roentgenogram shows minimal pneumothorax on the left side, with decrease in pleural effusion in the left costophrenic sulcus, and little change in the pulmonary lesion and normal hili. (*F*) Two and one-half months after *E* marked improvement is demonstrated with very minimal nodulations persisting. (*G*) Fifteen months after *F* (twenty-one months after *A*) the chest is normal except for very minimal nodulations.

phases. He was back to normal health three months after exposure.

CASE XII. (Fig. 7, *A–E*). A thirty-six year old white male developed malaise and generalized weakness one week after exposure. Five days later, he had fever and headache and the next day developed hard shaking chills, associated with severe sweating. The following day, his temperature was 104.8°F., and he was seen by his physician who started penicillin therapy. The patient was hospitalized three days later, at which time he had severe pruritus of the hands and extremities. The fever began to abate three weeks after exposure, although he continued to have profuse night sweats and low-grade fever for the following three weeks. He had lost 30 pounds in weight. The lungs were normal on physical examination. There were hard 2 cm. lymph nodes in both axillae. No fungi were grown from cultures of the sputum and bone marrow. The complement fixation test for histoplasmosis was negative three weeks after exposure, but five weeks after exposure, it was 1 to 64 in the yeast phase, and 1 to 16 in the mycelial phase. Scalene lymph node biopsy was done and no organisms were found on section; however, cultures were positive for *Histoplasma capsulatum*. Amphotericin B, 800 mg. three times a day, was started and

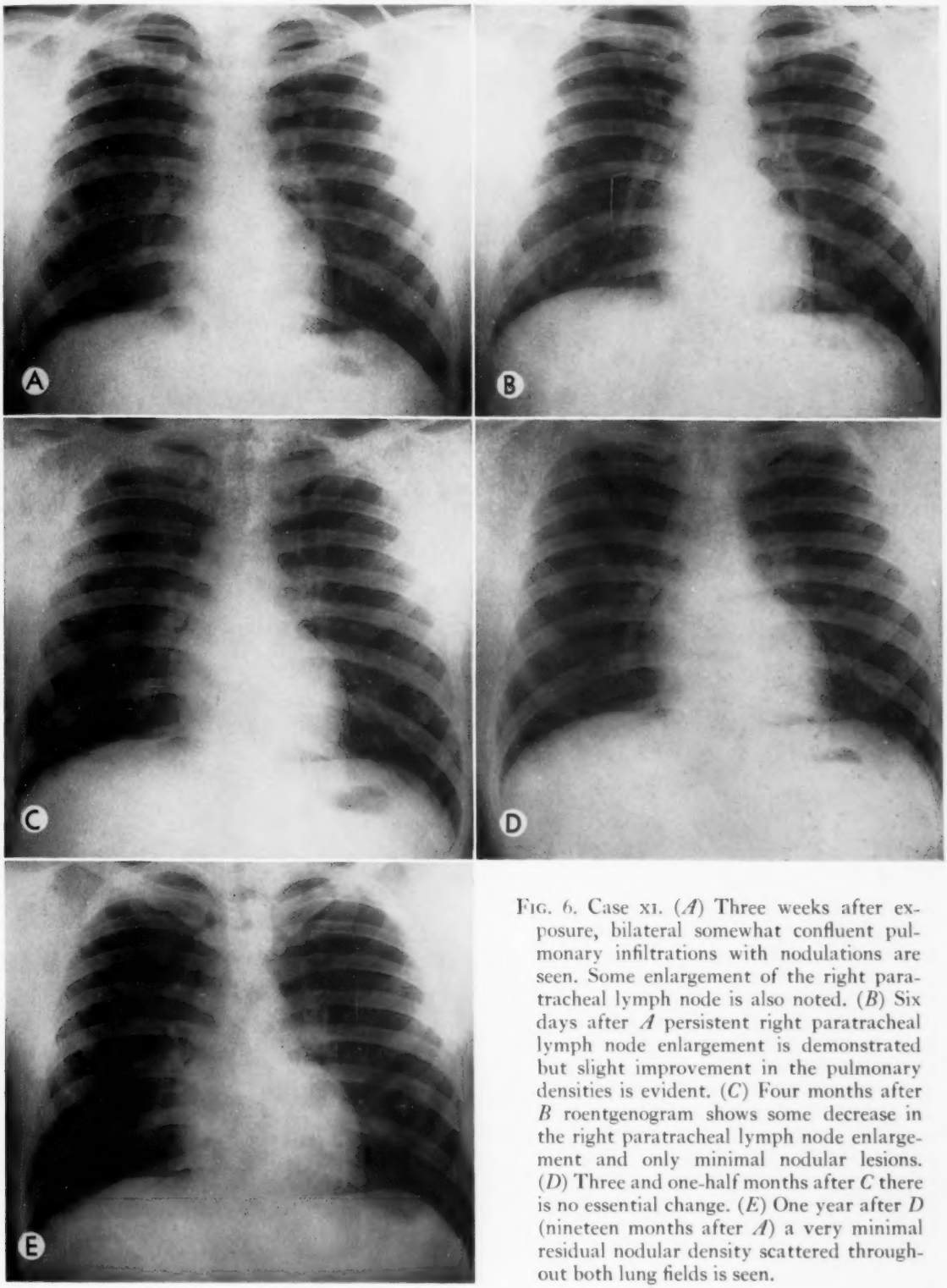

Fig. 6. Case xi. (*A*) Three weeks after exposure, bilateral somewhat confluent pulmonary infiltrations with nodulations are seen. Some enlargement of the right paratracheal lymph node is also noted. (*B*) Six days after *A* persistent right paratracheal lymph node enlargement is demonstrated but slight improvement in the pulmonary densities is evident. (*C*) Four months after *B* roentgenogram shows some decrease in the right paratracheal lymph node enlargement and only minimal nodular lesions. (*D*) Three and one-half months after *C* there is no essential change. (*E*) One year after *D* (nineteen months after *A*) a very minimal residual nodular density scattered throughout both lung fields is seen.

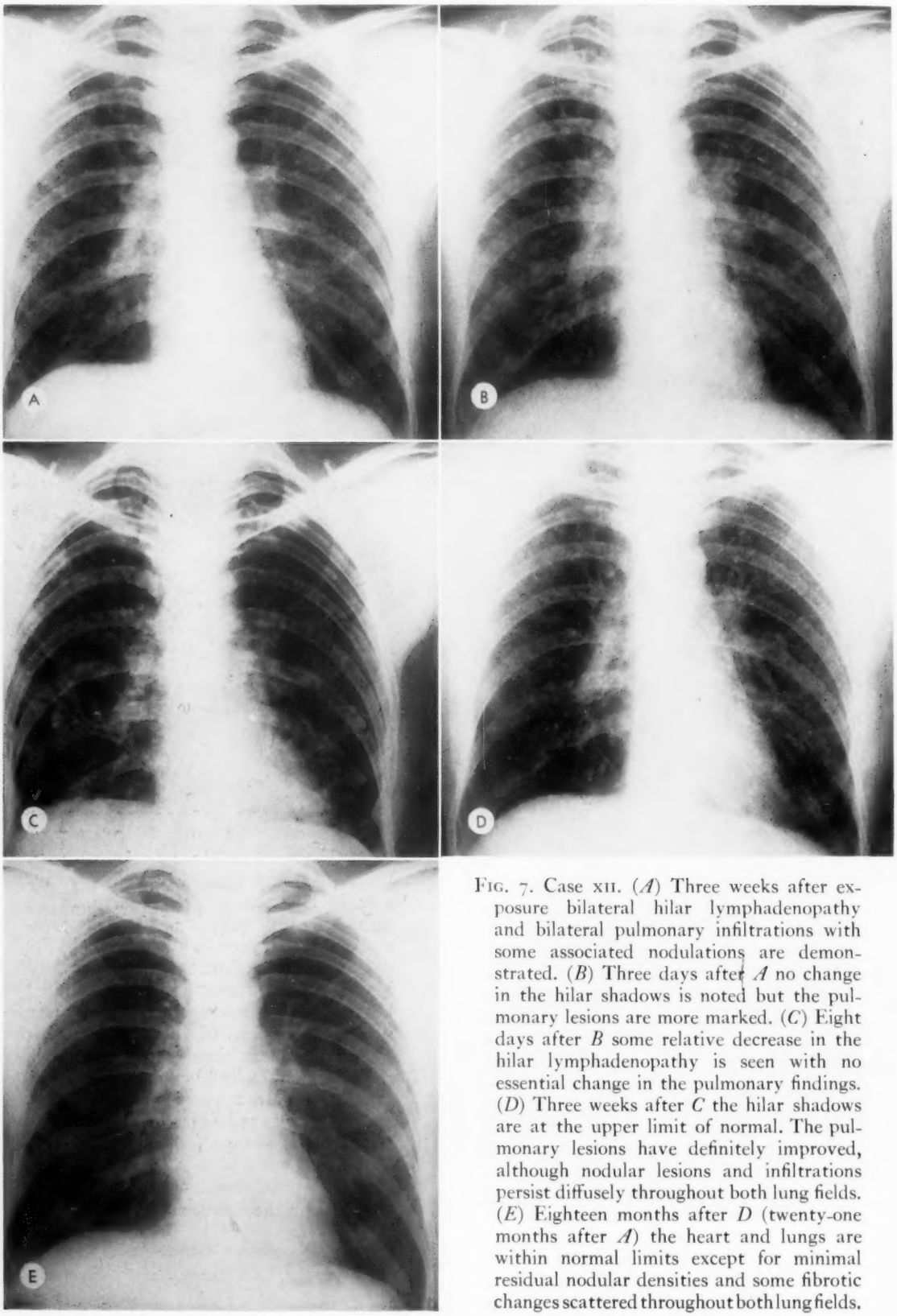

FIG. 7. Case XII. (*A*) Three weeks after exposure bilateral hilar lymphadenopathy and bilateral pulmonary infiltrations with some associated nodulations are demonstrated. (*B*) Three days after *A* no change in the hilar shadows is noted but the pulmonary lesions are more marked. (*C*) Eight days after *B* some relative decrease in the hilar lymphadenopathy is seen with no essential change in the pulmonary findings. (*D*) Three weeks after *C* the hilar shadows are at the upper limit of normal. The pulmonary lesions have definitely improved, although nodular lesions and infiltrations persist diffusely throughout both lung fields. (*E*) Eighteen months after *D* (twenty-one months after *A*) the heart and lungs are within normal limits except for minimal residual nodular densities and some fibrotic changes scattered throughout both lung fields.

continued for three months. The patient did not feel perfectly well until five months after the onset of the illness. Pulmonary function studies were normal seven months after the onset of the disease.

Case xiii. A seventy-one year old white male noted the onset of low-grade fever, profuse sweating, malaise, weakness and pleuritic pain ten days after exposure. The symptoms persisted for about one week and gradually subsided. He did not consult a physician. Shortly after the subsidence of the symptoms, he developed a hacking morning cough, productive of small amounts of whitish-gray sputum, which persisted for one month. He continued to have varying degrees of malaise and weakness. The complement fixation test was negative in the mycelial phase and positive 1 to 16 in the yeast phase. The histoplasmin skin test was positive five months after exposure. The chest roentgenogram was normal.

Case xiv. (Fig. 8, *A-D*). A forty-eight year old white male had been in good health until seven days after exposure, when he noted fever, diaphoresis, malaise, headache and myalgia. Symptoms were prominent for only two to three days. He did not feel completely well, however, and three weeks after exposure, he noted onset of cough and pleuritic pain which persisted for one week. At this time, the histoplasmin skin test was positive. The complement fixation test was positive 1 to 8 in the mycelial phase, and 1 to 16 in the yeast phase. Four months later, the complement fixation test was 1 to 16 in the mycelial phase and 1 to 32 in the yeast phase.

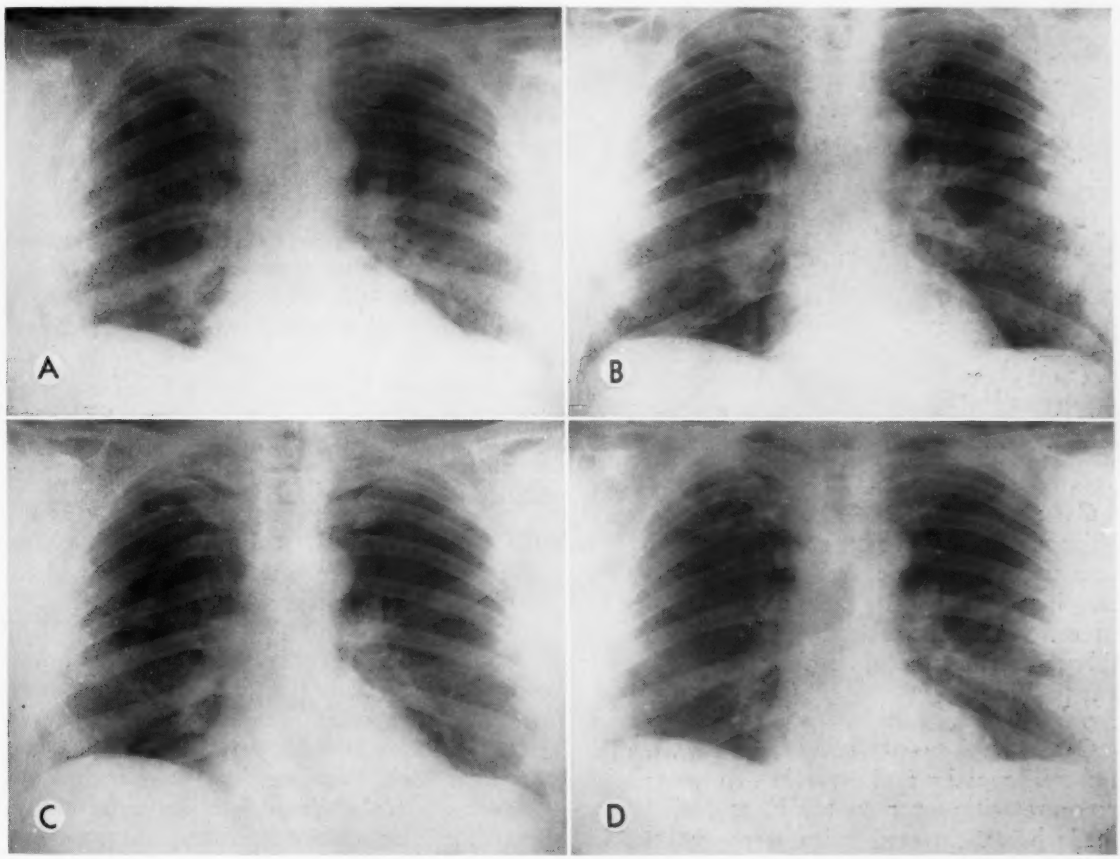

Fig. 8. Case xiv. (*A*) Chest roentgenogram two weeks after exposure showing minimal infiltration in the lower portion of the right hilar region and the right cardiophrenic angle. A few scattered nodular densities are present in the right mid and upper lung fields. (*B*) Ten days after *A* persistent increased density in the lower portion of the right hilar area, and several nodular densities in the right midlung field and in the left midlung field, are demonstrated. (*C*) Four months after *B* the chest is within normal limits. (*D*) Sixteen months after *C* (twenty months after *A*) the chest is within normal limits with no evidence of calcification.

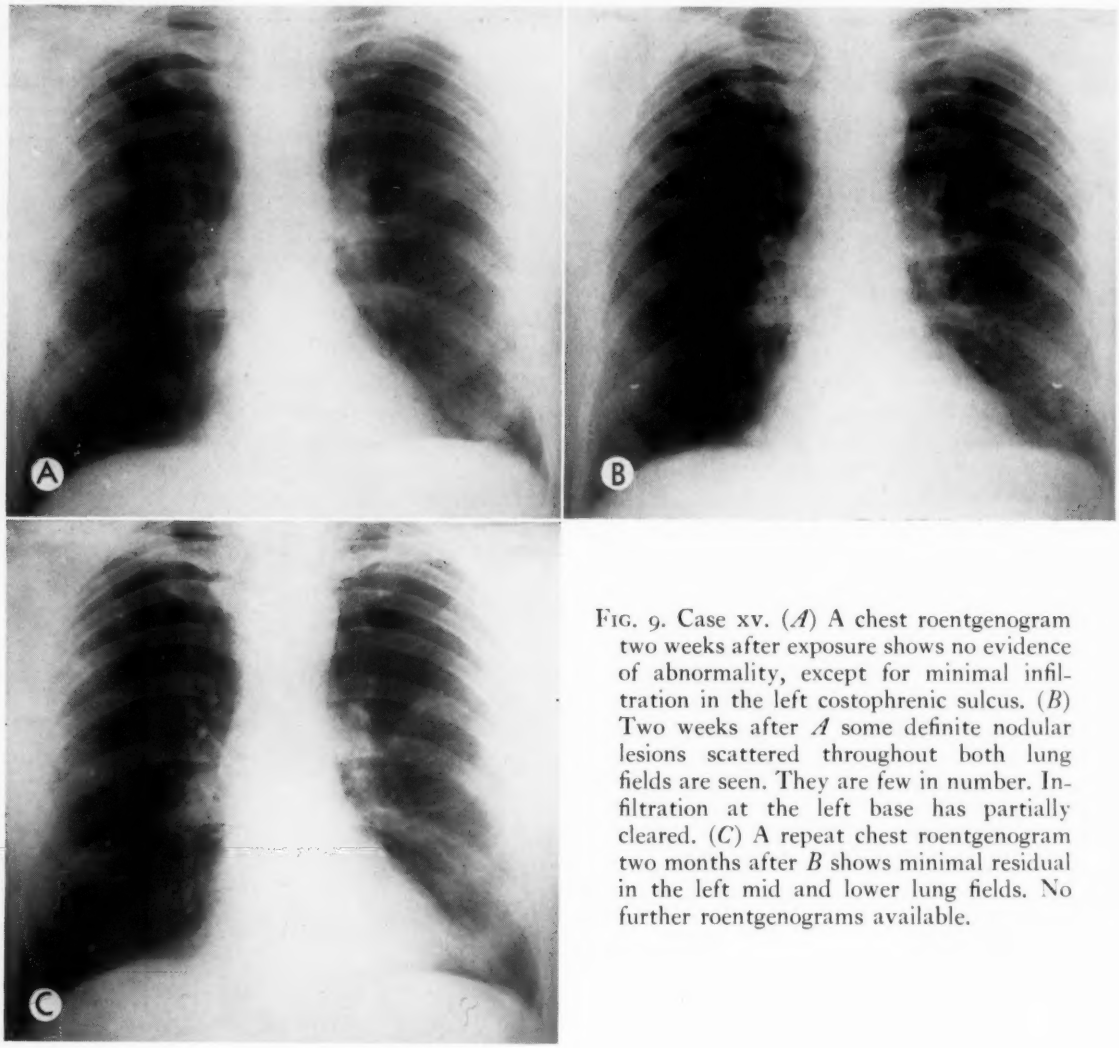

FIG. 9. Case XV. (*A*) A chest roentgenogram two weeks after exposure shows no evidence of abnormality, except for minimal infiltration in the left costophrenic sulcus. (*B*) Two weeks after *A* some definite nodular lesions scattered throughout both lung fields are seen. They are few in number. Infiltration at the left base has partially cleared. (*C*) A repeat chest roentgenogram two months after *B* shows minimal residual in the left mid and lower lung fields. No further roentgenograms available.

CASE XV. (Fig. 9, *A–C*). A fifteen year old white male noted the onset of fever, chills, malaise and myalgia one week after exposure. The examination showed a few scattered rales bilaterally. The histoplasmin test was questionably positive at this time (four months later it was positive).

CASE XVI. A twenty-two year old white male had mild malaise and myalgia two weeks after exposure with fever to 102°F. and chills and headaches. Scattered rales were present bilaterally. The histoplasmin test was positive three weeks after exposure. Four weeks after exposure, the complement fixation test was positive 1 to 8 in the mycelial phase and 1 to 16 in the yeast phase. Five months later the complement fixation test was negative in the mycelial phase, and 1 to 8 in the yeast phase. The patient's fever subsided two weeks after onset. A chest roentgenogram was negative.

CASE XVII. A twenty-seven year old white male noted the onset of fever to 102.5°F. two weeks after exposure. Two weeks later he noted shaking chills, diaphoresis, headache and myalgia. A physical examination showed a few dry rales bilaterally, but no other abnormality. Penicillin and chloramphenicol therapy was begun. Bone marrow biopsy done four weeks after exposure was negative for *Histoplasma capsulatum* by microscopic examination and culture. The condition remained essentially unchanged. Five weeks after exposure, the histo-

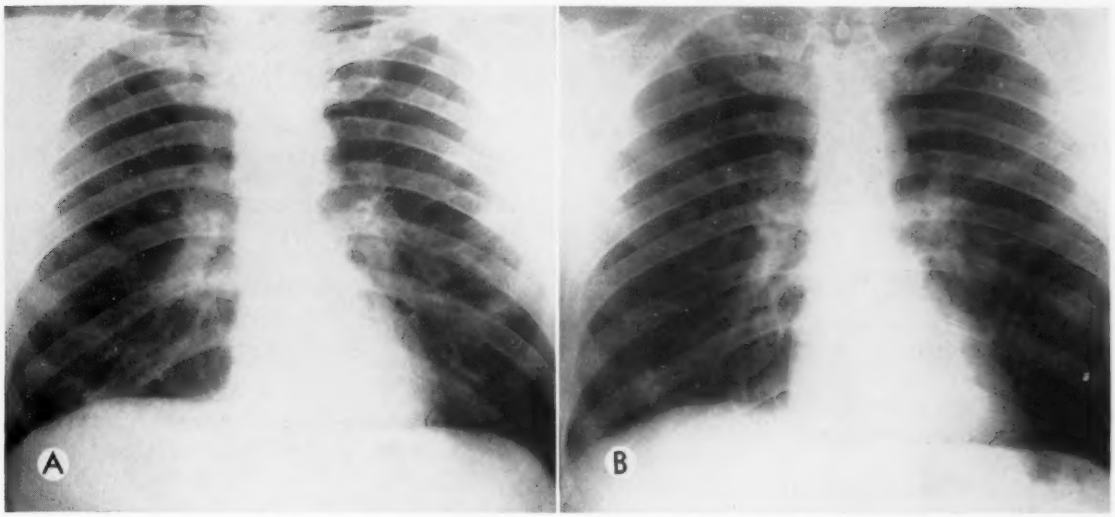

Fig. 10. Case xviii. (*A*) Roentgenogram taken four weeks after exposure shows bilateral hilar lymphadenopathy and small scattered infiltrations throughout both lung fields. (*B*) Eighteen months after *A* the chest appears to be normal.

plasmin skin test was positive and the complement fixation test was positive in a titer of 1 to 16 in the mycelial phase and 1 to 64 in the yeast phase. He gradually improved over a period of several weeks. The chest roentgenograms were not available for this patient.

Case xviii. (Fig. 10, *A* and *B*). A twenty-seven year old white male noted onset of malaise, fever, chills, and sweating two weeks after exposure. This was followed by cough and pleuritic pain. Scattered dry rales were present throughout both lung fields, but no other abnormalities were noted. The histoplasmin skin test was positive one month after exposure and in considerable time the patient lost twelve pounds in weight. He experienced brief episodes of pleuritic chest pain. Three months after exposure, the complement fixation test showed a 1 to 4 titer in the mycelial phase and a 1 to 128 titer in the yeast phase.

Case xix. A fifty-eight year old white female (health officer) noted onset of low-grade fever, malaise, weakness and headache fifteen days after exposure, at which time she had taken soil samples from the site of the epidemic area. At that time the illness was not recognized, and she gradually recovered. Seven months after exposure, a diagnosis of histoplasmosis was made on the basis of the history, roentgenographic appearance, a positive skin test, and a complement fixation titer of 1 to 4 in the mycelial phase and 1 to 16 in the yeast phase. A repeat complement fixation test two months later was negative in the mycelial phase and 1 to 4 in the yeast phase. Pertinent chest roentgenograms were not available for this patient.

SUMMARY

The roentgenographic findings in 19 cases of epidemic histoplasmosis occurring in Walworth, Wisconsin, are reported. In the very mild to mild cases, lymphadenopathy with minimal pulmonary nodulation and infiltration was seen. In the moderate and severe cases, the degree of hilar lymphadenopathy was more marked, and the nodulations and pulmonary infiltrations became more extensive with coalescence. A history of exposure to soil, approximately one to two weeks preceding the occurrence of symptoms and roentgenographic findings is strongly suggestive. The diagnosis may be confirmed by laboratory studies, particularly complement fixation tests, skin tests, and biopsy of scalene lymph nodes to demonstrate the organism. The findings are sufficiently suggestive to warrant their consideration in differential diag-

nosis between acute histoplasmosis, farmer's lung, sarcoidosis, noninfectious necrotizing granulomatosis, tuberculosis, metastatic malignant neoplasm, and other fungus diseases.

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REFERENCES

1. FELSON, B. Less familiar roentgen patterns of pulmonary granulomas; sarcoidosis, histoplasmosis and noninfectious necrotizing granulomatosis (Wegener's syndrome). AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1959, *81*, 211–223.
2. FISSEL, G. E. Acute fulminating histoplasmosis. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1956, *76*, 60–63.
3. FURCULOW, M. L. Histoplasmosis. Seminar Report, Summer 1958, Merck, Sharpe and Dohme.
4. FURCULOW, M. L. Development of calcification in pulmonary lesions associated with sensitivity to histoplasmin. *Pub. Health Rep.*, 1949, *64*, 1363–1393.
5. REEVES, R. J. Pulmonary histoplasmosis. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1954, *72*, 769–771.
6. WILCOX, K. R., JR., WAISBREN, B. A., and MARTIN, J. Walworth, Wisconsin, epidemic of histoplasmosis. *Ann. Int. Med.*, 1958, *49*, 388–418.

THE ROENTGENOGRAPHIC APPEARANCE OF EOSINOPHILIC LUNG (TROPICAL EOSINOPHILIA)*

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THE association of hypereosinophilia with pulmonary symptoms and persistent mottled shadows in the lungs was first reported in 1940 from a tuberculosis sanatorium in South India by Frimodt-Möller and Barton.[13] Among the many patients sent to the sanatorium, they discovered a group in whom a mistaken diagnosis of pulmonary tuberculosis had been made chiefly on the basis of the appearance of the chest roentgenograms. This consisted of an extensive mottling over both lung fields, usually evenly distributed; the size of the shadows was about 2 mm., and there was usually a certain amount of increased striation. In some patients the roentgenographic findings were more marked than in others. The general appearance was something similar to miliary tuberculosis or to silicosis. Routine blood counts revealed a marked eosinophilia in this group of patients. Weingarten,[25] who reported in 1943 that organic arsenic was an effective therapeutic agent, found similar roentgenographic changes in his patients. Since then numerous studies have been reported, chiefly from India, but also from other tropical countries establishing this condition as a distinct disease entity. It became known as tropical eosinophilia, eosinophilic lung or pulmonary eosinophilosis. Its recognition is important not only because it is a chronic disabling disease which is curable if diagnosed, but because of the possibility of mistaking it for other diseases such as pulmonary tuberculosis, bronchial asthma or bronchiectasis. The condition should therefore be considered in the differential diagnosis of mottled shadows and increased markings in the lung fields. It is the opinion of the writers that the roentgenographic appearance of the lungs alone is distinctive enough for the condition to be suspected, especially in countries where the disease is known to be prevalent.

The purpose of this paper is to present a description of the roentgenographic appearance of eosinophilic lung from a study of 550 patients seen in Singapore and to refer to the changes following treatment.

GENERAL DESCRIPTION OF THE DISEASE

Although Singapore has a predominantly Chinese population (77.6 per cent), the disease is seen most frequently in Indians (79.3 per cent), Chinese being less commonly affected and Europeans very rarely.[6] Cases have been recorded in children and in the elderly, but the peak incidence is found in the age group of twenty to forty years. Neither sex nor occupation seems to be an important etiologic factor.

The presenting symptom is chronic cough, which is most frequent and severe at night, occurring in paroxysms of a few minutes with mucoid or mucopurulent sputum sometimes streaked with blood. The paroxysms may be severe enough to force the patient to sit up in bed and sleep is badly disturbed. A feeling of suffocation is present after each bout of coughing, and breathlessness is at times so severe and prolonged as to resemble bronchial asthma or even status asthmaticus. There is relative freedom from cough during the day, but there is considerable fatigue. Low fever may occur for varying periods and some loss of weight is usually present. The abnormal physical signs are confined to the

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chest and consist of coarse crepitations and scattered rhonchi heard over the bases of the lungs; bronchial spasm may be present in severe cases. There is neither splenomegaly nor lymphadenopathy. A persistent massive eosinophilic leukocytosis (usually more than 5,000 eosinophils per cu. mm. and less often between 3,000 and 5,000 eosinophils) is always present and is an essential feature of the disease; the peripheral blood picture is otherwise normal. The erythrocyte sedimentation rate is usually elevated and is a feature differentiating eosinophilic lung from allergic bronchial asthma, which is often simulated. The disease responds dramatically to a course of organic arsenicals, usually given intravenously every week for six to eight injections. There is an amelioration of symptoms following the first injection and within three to four weeks the patient is well. An immediate and then a further gradual fall in the number of circulating eosinophils occurs, and the erythrocyte sedimentation rate subsequently returns to normal. Relapses or re-infections are observed in about 10 per cent of cases, but the response to treatment is again satisfactory. More recently successful results, comparing very favorably with those obtained with organic arsenicals, have been obtained in the treatment of the disease by the use of diethylcarbamazine.[4,7,8,14,15] Besides symptomatic improvement, clearing of the abnormal roentgenographic picture and decrease in the elevated erythrocyte sedimentation rate to normal, a distinctive feature is the fall in the circulating eosinophils such as occurs with arsenotherapy. Relapses show the same response to second courses of diethylcarbamazine. The use of organic arsenicals has sometimes resulted in encephalopathy and death, therefore diethylcarbamazine is to be preferred, as it is not only effective but safe. The cause of eosinophilic lung is not known. It does not resemble human filariasis and microfilariae are not found in the blood; but, in view of the response to treatment with diethylcarbamazine and the finding of positive reactions to the filarial complement fixation test which becomes negative after treatment, an infection with species of filarial worms normally found in non-human hosts has been postulated.[3,10,11]

ROENTGEN FINDINGS

The typical roentgenogram of the chest shows increased markings and mottlings in both lung fields. The markings, which extend almost to the periphery, are most pronounced in the middle and lower zones. Numerous, discrete, soft, round shadows with ill-defined margins, varying in size from a pin's head to about 4 mm. in diameter, are seen mostly in the basal and mid-zone areas, lessening in degree from below upwards and leaving the apices clear. These findings are characteristic enough to make a roentgenologic diagnosis of eosinophilic lung even though the leukocyte count is not known. Mottlings need not be present in every case, but it is unusual to find mottlings without increased markings. The extent of the increase in markings and the degree of mottling show some variation, depending on the duration of the disease, such changes being marked early in the course of the disease within six months after the onset.

A detailed examination of the pulmonary roentgenograms of 550 cases of eosinophilic lung obtained before treatment showed that the roentgenographic findings may be classified into five well-defined groups (Table 1).

TABLE I

ROENTGENOLOGIC FINDINGS IN EOSINOPHILIC LUNG

	No. of Cases	Per Cent
I. Normal appearance	9	1.6
II. Increased markings	138	25.1
III. Increased markings and mottlings	206	37.5
IV. Increased markings, mottlings and pneumonitis	167	30.4
V. Extensive changes, being severe examples of Group IV	30	5.4
	550	100.0

The most commonly found roentgenographic abnormality was an increase in lung markings of varying extent appearing as fine, moderately thick, or rather coarse, massive strands; they were often hazy and appeared heavier in the bases, more so on the right side (Fig. 1). In many cases the markings when viewed end on appeared as tiny hazy opacities which could be called mottlings. Often some of the basal markings exhibited fine radiolucent streaks within them, giving the appearance of apparent bronchial dilatation.

The next common finding consisted of mottlings (Fig. 2) which were hazy and of medium density, and showed slight variation in size from 2 mm. to 4 mm. Although usually found in the bases, they were sometimes generalized, but even in such cases the mottling was more marked in the lower zones and the apices were usually spared. Rarely, the mottlings were more numerous in the upper zones making differentiation from tuberculosis difficult.

Less frequently, there were larger, diffuse, homogeneous opacities with indistinct outlines, 2 cm. to 4 cm. in size; these were single or multiple and were usually found in the lower zones, more often on the right. They probably represented a conglomeration of the mottled shadows and were regarded as areas of pneumonitis (Fig. 3). Differentiation from tuberculosis was difficult if these infiltrations were located in the upper zones. In children such opacities were often centrally located simulating hilar lymphadenopathy, consolidation or pulmonary edema.

Extensive changes (Fig. 4) were sometimes seen and consisted of increased markings, extensive mottling throughout all lung zones, and numerous scattered areas of homogeneous opacities, making the differentiation from tuberculosis difficult.

Additional roentgenologic findings consisted of: pleural thickening, 217 cases (39.5 per cent); heavy hilar shadows, 81 cases (14.7 per cent); emphysema, 85 cases (15.5 per cent); emphysematous bullae, 17 cases (3.1 per cent); pulmonary tuberculosis, 50 cases (9.1 per cent); and

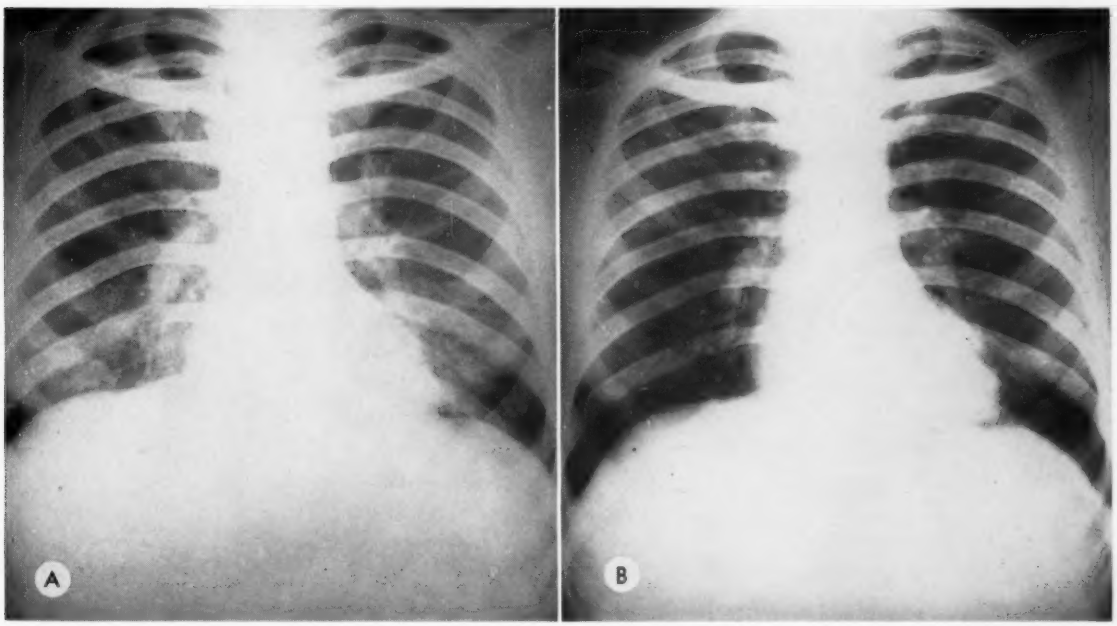

Fig. 1. (*A*) Increased lung markings only. Thirty year old male Indian with cough and breathlessness of two months' duration. Eosinophils 22,420 per cu. mm., erythrocyte sedimentation rate 19 mm. (*B*) Considerable improvement after treatment with diethylcarbamazine. Eosinophils 2,444 per cu. mm., erythrocyte sedimentation rate 5 mm.

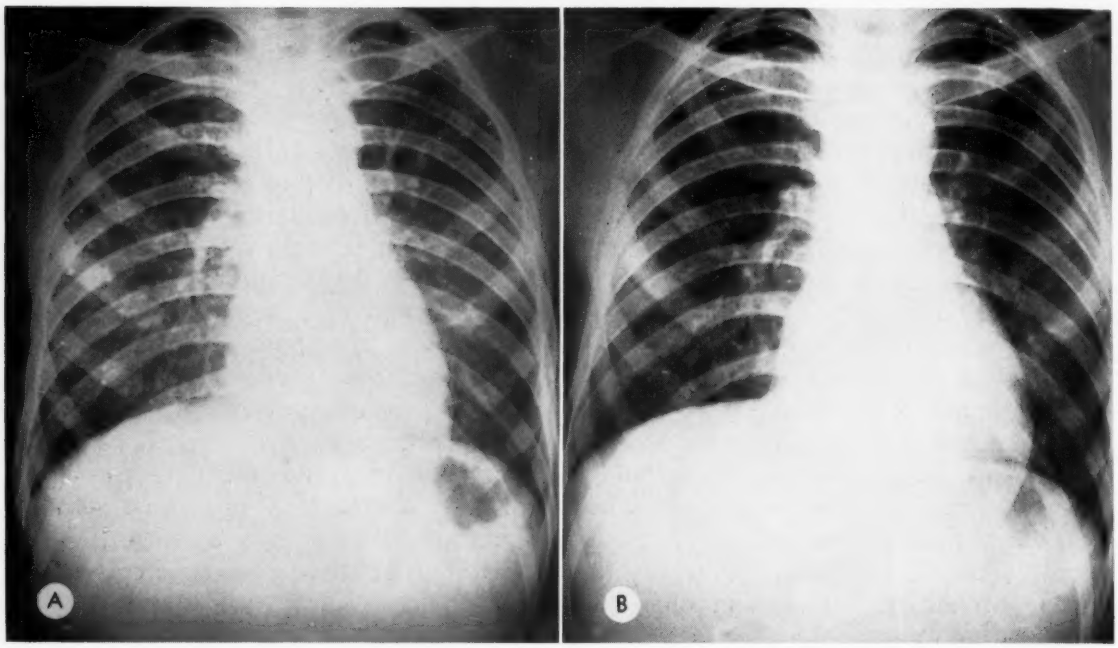

FIG. 2. (*A*) Increased lung markings and mottlings. Fifteen year old male Chinese with cough of two months' duration. Eosinophils 23,800 per cu. mm., erythrocyte sedimentation rate 48 mm. (*B*) Considerable improvement after treatment with diethylcarbamazine. Eosinophils 2,240 per cu. mm., erythrocyte sedimentation rate 17 mm.

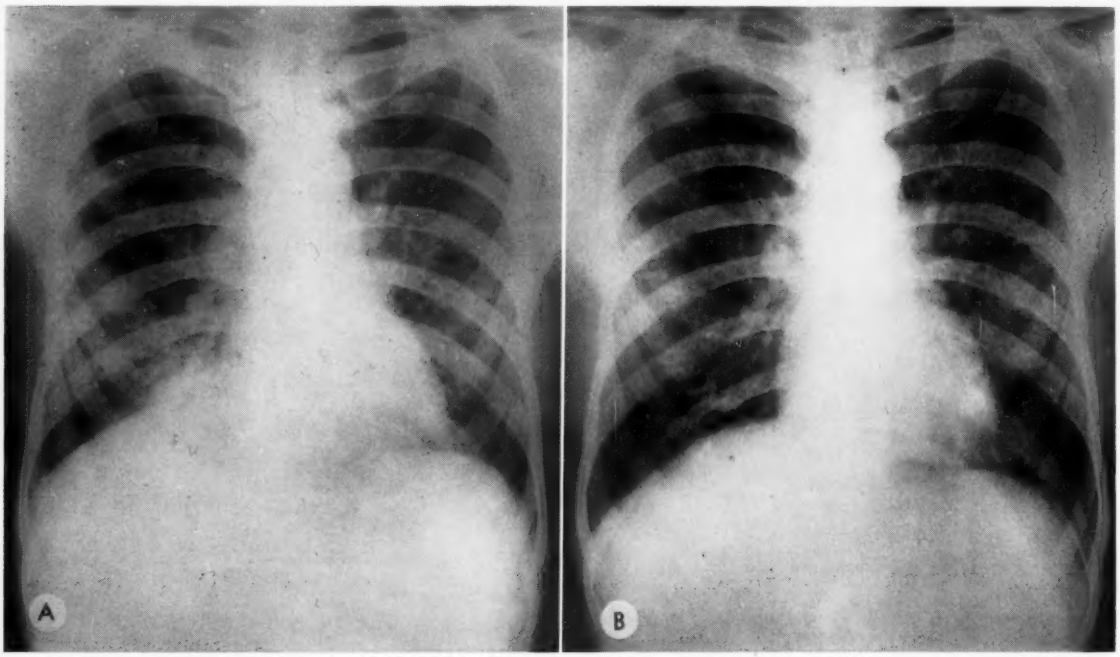

FIG. 3. (*A*) Increased lung markings, mottlings, and pneumonitis. Twenty-three year old male Indian with cough and breathlessness of one month's duration. Eosinophils 34,760 per cu. mm., erythrocyte sedimentation rate 75 mm. (*B*) Considerable improvement after treatment with diethylcarbamazine. Eosinophils 917 per cu. mm., erythrocyte sedimentation rate 24 mm.

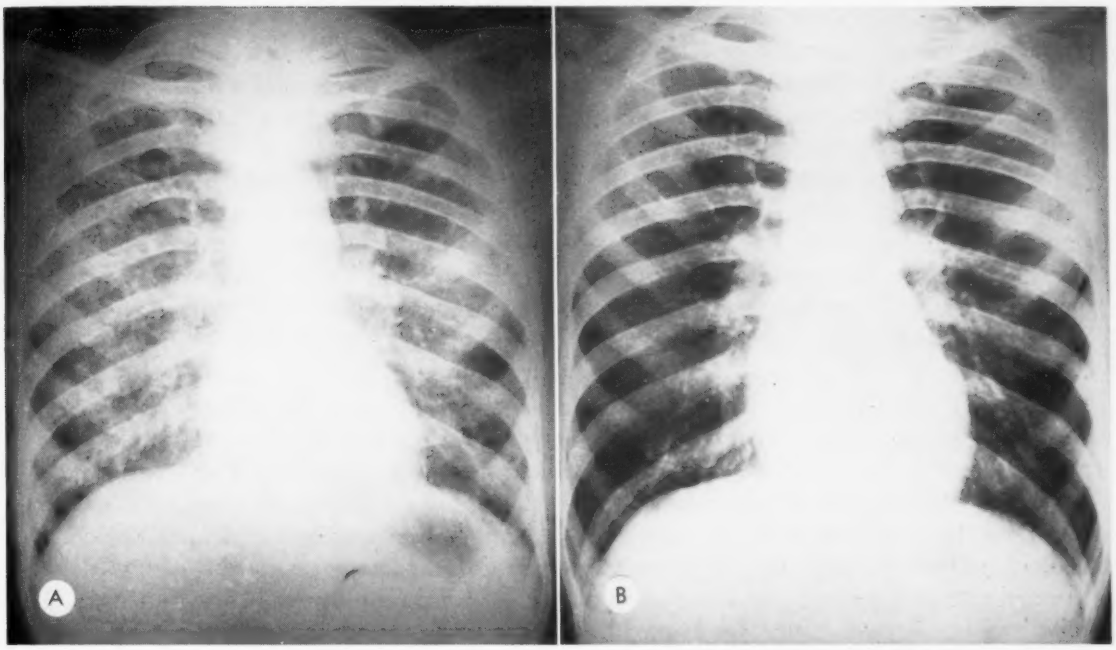

Fig. 4. (*A*) Extensive changes. Twenty-six year old male Indian with cough and breathlessness of three weeks' duration. Eosinophils 22,704 per cu. mm., erythrocyte sedimentation rate 44 mm. (*B*) Considerable improvement after treatment with diethylcarbamazine. Eosinophils 1,656 per cu. mm., erythrocyte sedimentation rate 10 mm.

fracture of ribs, 20 cases (3.6 per cent).

Although a common finding was pleural thickening, this was minimal and present most often in the basal zones, especially on the right side; the thickening seldom exceeded 2 mm. to 3 mm. in width. Frank pleural effusions were never seen. The right middle fissure was visualized and thickened in a large number of cases.

Heavy hilar shadows with an irregular border were less often seen, but these were invariably found in association with very heavy lung markings which merged with the hilar shadows. They were not suggestive of lymph node enlargement.

Increased translucency of lung fields with blurring of details was present, suggesting pulmonary emphysema; many of the patients in whom this was found were breathless and could not hold their breath well. Small radiolucent areas, regarded as emphysematous bullae, were occasionally seen.

Fractures of ribs were detected. The lower ribs were most often involved and as the fractures appeared to be recent, they were considered to have occurred during the severe bouts of coughing. One case showed fracture of two ribs, while the remainder were single fractures. No history of trauma or pain was obtained in these patients.

Roentgenologic evidence of pulmonary tuberculosis was found in 50 patients in this series. Eleven of them, who were considered to be suffering from active tuberculosis, had small fibroproductive lesions in the upper zones, while the remainder had quiescent or healed lesions associated with calcification of the hilar lymph nodes. In 2 patients the active lesions progressed and cavitation became evident after the patients had been cured of eosinophilic lung.

The cardiac shadow was normal except in 2 instances where the configuration was suggestive of mitral stenosis and atrial septal defect, respectively. These diagnoses were confirmed on clinical examination.

Bronchography was done in 17 cases di-

agnosed as eosinophilic lung. Bronchospasm was usually present and was minimal or moderate in degree. Minimal bronchiectasis, often localized to one basal segment and involving the smaller or terminal bronchioles, was present in 5 cases.

Eleven patients with eosinophilic lung were observed for periods of two to seven months without any specific treatment, roentgenograms being taken at two week or monthly intervals during the period of observation. The abnormal roentgenographic picture of increased markings and mottlings persisted and did not clear until specific treatment was given.

It was possible to study the roentgenograms of 16 patients who had relapses with chest symptoms and hypereosinophilia about one year after their first attacks had been cured. Increased markings and mottlings were present once again in the roentgenograms, varying only in degree when compared with the pretreatment roentgenograms of the first attacks.

ROENTGEN FINDINGS AFTER TREATMENT

The number of cases under review consists of two groups, an earlier one of 202 patients treated with intravenous injections of neohalarsine (oxophenarsine tartrate) and a more recent group of 348 patients treated orally with diethylcarbamazine. The criteria of cure were an amelioration of symptoms and a return of the eosinophil count to less than 3,000 cells per cu. mm.

The roentgenograms of 110 cases treated with neohalarsine and considered cured were available for study. As the course of weekly injections lasted six weeks, roentgenograms were taken at the end of the course and one month later. These showed disappearance of the lung mottlings within a month of completion of treatment, but the increased lung markings took longer to return to normal, slight accentuation being present in almost all cases so that the roentgenograms could not be called entirely normal. In 93 cases, therefore, there was roentgenographic improvement, while 17, who had had minimal roentgenographic abnormalities before treatment, showed no appreciable change.

The more recent group of 348 patients was treated with a five-day course of diethylcarbamazine and roentgenograms of the chest were taken one week and three weeks after completion of treatment. Moderate to considerable clearing of the abnormalities was noted on the first roentgenogram after treatment and further improvement was apparent on the second roentgenogram. Mottlings and areas of pneumonitis cleared completely or decreased considerably. The lung markings became less intense, but tended to persist in a slightly accentuated form which could be detected only on comparison with previous roentgenograms. Although only 94 of the roentgenograms taken after treatment were considered to be normal, the remainder showed considerable improvement when compared to pretreatment roentgenograms. The roentgenographic findings in this group before and after treatment are given in Table II.

After treatment, patients were able to take deeper breaths and lung fields were better aerated. In spite of this, in a few instances there appeared to be a slight increase in the transverse diameter of the cardiac shadow of about 3 mm. to 5 mm. This observation could not be explained.

DIFFERENTIAL DIAGNOSIS

It is important not to mistake the roentgenographic findings of eosinophilic lung for those of miliary tuberculosis, which may be simulated. In the former condition the mottlings, which are associated with heavy markings, are indistinct, less dense and not of uniform size as are those present in miliary tuberculosis. Further, the lesions in eosinophilic lung are mainly concentrated over the basal zones diminishing in intensity in the middle and upper zones. However, in the few instances where mottlings and areas of pneumonitis are extensive and widely distributed, roentgenographic differentiation from tuberculosis is

Table II

RESULTS OF TREATMENT WITH DIETHYLCARBAMAZINE

Roentgenologic Findings	Before Treatment		After Treatment	
	No. of Cases	Per Cent	No. of Cases	Per Cent
I. Normal appearance	9	2.6	94	27.0
II. Increased markings	120	34.5	204	58.6
III. Increased markings and mottlings	144	41.4	36	10.4
IV. Increased markings, mottlings and pneumonitis	45	12.9	14	4.0
V. Extensive changes	30	8.6	—	—
	348	100.0	348	100.0

difficult except on the basis of improvement following treatment with diethylcarbamazine. It is in these patients that the finding of hypereosinophilia clearly differentiates the two diseases clinically. The heavy hilar shadows should not be mistaken for tuberculous lymphadenopathy.

The differentiation from coexisting tuberculosis also becomes difficult or even impossible, when diffuse opacities are found in the upper zones of the lungs in addition to the typical changes of increased striations, mottlings and pneumonitis in the middle and lower zones. In such cases a reexamination after adequate treatment for eosinophilic lung will reveal a clearing of the roentgenographic abnormalities in the middle and lower zones, but in the upper zones the opacities persist if due to tuberculosis. In cases of eosinophilic lung complicated by active pulmonary tuberculosis, the erythrocyte sedimentation rate remains elevated and does not return to normal after treatment although other features of eosinophilic lung have disappeared.

Basal shadows and increased lung markings are also seen in bronchitis, bronchiolitis and cardiac failure. An abnormal cardiac shadow will distinguish the latter condition from eosinophilic lung, in which condition the heart is normal, but differentiation from bronchitis and bronchiolitis is difficult and can only be resolved by doing an eosinophil cell count.

Early cases of silicosis, asbestosis and bagassosis may simulate eosinophilic lung, but none of these conditions is accompanied by an eosinophilic leukocytosis.

The roentgenographic features in Loeffler's syndrome are essentially transitory and consist of rapidly shifting infiltrations which are variable in site and extent, being unilateral, bilateral, homogeneous or nodular, involving large or small areas of the lungs. The transitory occurrence of the eosinophilia, which is usually mild, is also a typical feature. It is the opinion of the authors that this condition and eosinophilic lung are two separate diseases, the latter being a chronic incapacitating illness with a persistent massive eosinophilic leukocytosis of a degree not usually seen in Loeffler's syndrome. Nor should eosinophilic lung be confused with eosinophilic granuloma of the lung, which is a form of histiocytosis affecting other systems as well and is unaccompanied by hypereosinophilia.

Atypical pneumonia, coccidioidomycosis, bronchomycosis and carcinomatosis may be simulated, but should lead to no real difficulty in differentiation from eosinophilic lung if the characteristic picture is kept in mind and correlated with hematologic findings.

When roentgenographically eosinophilic lung is suspected, confirmation should be obtained by means of a blood cell count. In the absence of an eosinophilic leukocytosis, the roentgen diagnosis should be revised.

It is useful, however, to draw the attention of the clinician to the possibility of eosinophilic lung in doubtful cases so that a blood cell count is not omitted.

DISCUSSION

The general roentgenographic description by various authors[1,2,4,5,12,13,16–22,24,25] who have studied series of cases does not differ essentially from the description based on the group studied in Singapore. Ball,[1] who made a detailed analysis in 66 cases, classified the roentgenographic findings into the following categories: increased striations, 39 cases (59 per cent); miliary mottlings, 31 cases (46 per cent); hilar lymph node enlargement, 31 cases (46 per cent); and no abnormality, 4 cases (6 per cent). Enlargement of the hilar lymph nodes, which was observed more frequently in children than adults, is not mentioned by other authors although increased hilar shadows, considered to be a part of the increased lung markings, have been noted. We have observed increased hilar shadows more often in children, but have not considered them to be caused by enlarged lymph nodes. Basu[2] made a detailed roentgenographic study of 87 cases and gave his findings as follows: normal, 2 cases (2.3 per cent); emphysema, 19 cases (21.8 per cent); increased striations, 59 cases (67.8 per cent); enlarged hilar shadows, 65 cases (74.7 per cent); pleural thickening, 3 cases (3.4 per cent); diffuse mottling, 29 cases (33.3 per cent); ground glass appearance, 2 cases (2.3 per cent); snow storm appearance, 4 cases (4.6 per cent); and minimal infiltration, 7 cases (8.0 per cent).

An unusual finding mentioned by Viswanathan[22] was the appearance of a pleural effusion in a patient while under investigation; the aspirated fluid contained a large number of eosinophils. Although pleural effusions were not seen in the present series, minimal pleural thickening was noted in 39.5 per cent of patients who did not have symptoms or signs suggestive of pleurisy.

Another uncommon finding is the presence of cough fractures of the ribs detected in the present series and not mentioned by other authors. These patients did not complain of localized pain and the abnormality was only detected on roentgenograms.

In cardiac patients who develop eosinophilic lung, the symptoms and roentgen signs due to the latter disease must not be mistaken for cardiac failure as occurred in 2 patients suffering from mitral stenosis and atrial septal defect in this series. Cough is not a presenting symptom of cardiac failure and a blood cell count differentiates the two conditions.

There is general agreement, however, among the authors mentioned above that the roentgen changes are not necessarily present in every patient and that, therefore, the diagnosis should not be dependent on the roentgenogram alone, but on the hypereosinophilia, without which the diagnosis of eosinophilic lung is untenable.

In endemic areas, the diagnosis of eosinophilic lung can often be suspected by those who have seen previous cases on the basis of the history alone, but a leukocyte count is necessary to confirm the diagnosis. However, it is not uncommon to find that the condition is not suspected clinically, patients being referred to the radiologist with the diagnosis of pulmonary tuberculosis, bronchitis, bronchiectasis or bronchial asthma. It is in this group of patients that the radiologist is helpful in suggesting the correct diagnosis to the clinician on the basis of the roentgenographic findings alone. A leukocyte count would then differentiate eosinophilic lung from other pulmonary conditions which it simulates and which are relatively difficult to treat.

The nature of the mottled shadows seen on roentgenograms is not known. It has been suggested that these lesions represent areas of edema, focal pneumonia or clumps of eosinophil cells. As the disease is not fatal in itself, necropsy observations are not possible. In 2 patients who died of encephalopathy as a result of treatment with organic arsenicals, histologic examination showed that the essential lesion was a focal

granulomatous reaction around necrotic tissue.[9,23] It is likely that these granulomas, considered to be of the foreign-body type, are partially responsible for the mottled shadows seen on the roentgenograms.

SUMMARY

A study of the roentgenographic findings of 550 cases of eosinophilic lung showed that the essential changes were increased striations and mottlings associated sometimes with small areas of pneumonitis. It is felt that these changes are distinctive enough for a diagnosis to be made, especially in countries where the disease is endemic. Treatment with organic arsenicals or diethylcarbamazine resulted in a regression of the roentgenographic abnormalities.

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REFERENCES

1. Ball, J. D. Tropical pulmonary eosinophilia. *Tr. Roy. Soc. Trop. Med. & Hyg.*, 1950, *44*, 237–258.
2. Basu, S. P. X-ray appearances in lung fields in tropical eosinophilia. *Indian M. Gaz.*, 1954, *89*, 212–217.
3. Buckley, J. J. C. Tropical pulmonary eosinophilia in relation to filarial infections (*Wuchereria* SPP) of animals. *Tr. Roy. Soc. Trop. Med. & Hyg.*, 1958, *52*, 335–336.
4. Chaudhuri, R. N. Tropical eosinophilia. *J. Indian M. A.*, 1956, *27*, 195–201.
5. Coutinho, A. Tropical eosinophilia: clinical, therapeutic and etiologic considerations. Experimental work. *Ann. Int. Med.*, 1956, *44*, 88–104.
6. Danaraj, T. J. Eosinophilic Lung. A study of 150 cases seen in Singapore. Papineau Studios, Singapore, 1951.
7. Danaraj, T. J. Treatment of eosinophilic lung (tropical eosinophilia) with hetrazan: preliminary report. *Proc. Alumni A. Malaya*, 1956, *9*, 172–187.
8. Danaraj, T. J. Treatment of eosinophilic lung (tropical eosinophilia) with diethylcarbamazine. *Q. J. Med. Oxf.*, 1958, *27*, 243–263.
9. Danaraj, T. J. Pathologic studies in eosinophilic lung (tropical eosinophilia). *A.M.A. Arch. Path.*, 1959, *67*, 515–524.
10. Danaraj, T. J., da Silva, L. S., and Schacher, J. F. Filarial complement fixation test in eosinophilic lung (tropical eosinophilia): preliminary report. *Proc. Alumni A. Malaya*, 1957, *10*, 109–116.
11. Danaraj, T. J., da Silva, L. S., and Schacher, J. F. Serologic diagnosis of eosinophilic lung (tropical eosinophilia) and its etiologic implications. *Am. J. Trop. Med.*, 1959, *8*, 151–159.
12. Díaz-Rivera, R. S., Ramos-Morales, F., García-Palmieri, M. R., Sotomayor, Z. R., and Cintrón-Rivera, A. A. Infiltrative eosinophilia. *Ann. Int. Med.*, 1956, *45*, 459–479.
13. Frimodt-Möller, C., and Barton, R. M. Pseudo-tuberculous condition associated with eosinophilia. *Indian M. Gaz.*, 1940, *75*, 607–613.
14. Ganatra, R. D., and Lewis, R. A. Hetrazan in tropical eosinophilia. *Indian J. M. Sc.*, 1955, *9*, 672–681.
15. Ganatra, R. D., Sheth, U. K., and Lewis, R. A. Diethylcarbamazine (hetrazan) in tropical eosinophilia. *Indian J. M. Research*, 1958, *46*, 205–222.
16. Jhatakia, K. U. Observations on eosinophilic lung. *Indian M. Gaz.*, 1946, *81*, 179–184.
17. Joseph, A. D. Tropical eosinophilia. *Indian M. Gaz.*, 1946, *81*, 515–520.
18. Lal, H. B. Tropical eosinophilia; report on 15 cases. *Indian M. Gaz.*, 1945, *80*, 30–32.
19. Menon, I. G. K. Tropical eosinophilia. *Indian M. Gaz.*, 1945, *80*, 24–30.
20. Patel, N. D. Benign eosinophilia with pulmonary shadows. *Indian Physician*, 1945, *4*, 93–114.
21. Soysa, E., and Jayawardena, M. D. S. Pulmonary acariasis; possible cause of asthma. *Brit. M. J.*, 1945, *1*, 1–6.
22. Viswanathan, R. Pulmonary eosinophilosis. *Indian M. Gaz.*, 1945, *80*, 392–396.
23. Viswanathan, R. Post-mortem appearances in tropical eosinophilia. *Indian M. Gaz.*, 1947, *82*, 49–50; also *J. Trop. Med.*, 1947, *50*, 93–95.
24. Viswanathan, R. Pulmonary eosinophilosis. *Quart. J. Med.*, 1948, *17*, 257–270.
25. Weingarten, R. J. Tropical eosinophilia. *Lancet*, 1943, *1*, 103–105.

IDIOPATHIC PULMONARY HEMOSIDEROSIS IN ADULTS*

REPORT OF A CASE AND REVIEW OF THE LITERATURE

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IN IDIOPATHIC pulmonary hemosiderosis there appears in the alveoli, the walls of the alveoli and capillaries and, also, in the bronchial walls and mediastinal lymph nodes phagocytized and free hemosiderin, and characteristically no deposition of hemosiderin is found in other areas of the organism (except occasionally in the liver and spleen).[29] The deposition of hemosiderin in the lung takes place diffusely, or in focal areas. Pulmonary hemosiderosis may occur, it has often been noted, in connection with pure mitral stenosis, although the pulmonary foci are more discrete and the nodules more sharply defined than in idiopathic pulmonary hemosiderosis; also, it may develop in long standing left cardiac insufficiency[18] and infrequently in aortic insufficiency,[20] although the pulmonary foci in the last group are not well defined. These three forms of the disease are observed mostly in adults, while idiopathic pulmonary hemosiderosis occurs in children and adolescents as well as in adults. The derangement in the circulation, apparently in the terminal pulmonary vascular structures, leads to a widespread serious diapedesis or hemorrhage from the small capillaries; as a result, hemosiderosis of the lungs takes place. The roentgenographic pattern is similar to that of miliary tuberculosis, sarcoidosis, carcinomatosis and the pneumoconioses. These pulmonary infiltrates are of a special interest to the radiologist since they can be the source of numerous diagnostic difficulties and errors. The clinical importance of differentiating between these diseases and idiopathic pulmonary hemosiderosis becomes more urgent with the increasing number of cases being described. Joseph *et al.*,[25] in 1958, found 56 cases of idiopathic pulmonary hemosiderosis in the world literature; 10 of which are included in our 37 collected adult cases.[1,8,17,19,30,46,49,50] Wynn-Williams and Young[55] reported one new case in an adult and found 15 cases of adults with idiopathic pulmonary hemosiderosis in the literature. Shoeniger *et al.*,[41] in 1958, found 60 cases of adults and children in the literature. Boyd[2] collected 26 adult cases from the literature and reported 3 new cases in adults, making a total of 29.

In this paper, a new case of idiopathic pulmonary hemosiderosis in a white male, twenty-seven and one-half years of age, is reported. In addition, 37 cases in adults having attained the age of sixteen years or more were found in the world literature. Pertinent clinical and roentgenographic data are reviewed.

Idiopathic pulmonary hemosiderosis was first described by Virchow[47] in 1856 as "brown lung induration;" no abnormalities of the cardiac structures or congestion in the pulmonary vascular tree, as found in mitral stenosis, were observed by the pathologist. In 1931, Ceelen[6] described the findings of 2 necropsies, one of a five and one-half year old male and the other of a ten year old female, in which he found an unusually large quantity of hemosiderin pigment deposition in the lungs. The walls of the alveoli and the interlobar and peribronchial connective tissues were extraordinarily thickened; destruction of the elastic fibers of alveolar walls and capillaries was observed. Massive quantities of alveolar epithelial cells were noted. In neither case did the cardiac findings give sufficient

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explanation for the severe circulatory derangement of the pulmonary vascular tree.

REPORT OF A CASE

A white male poultry farmer was admitted to the Veterans Administration Hospital for the first time at the age of twenty-one on July 5, 1953. He had been in excellent health until seven weeks prior to admission, when he noted onset of weakness, pallor, dizziness and mild headache.

On physical examination the blood pressure was 120/60, pulse 124, and temperature 101.2° F. Marked pallor of skin and mucous membranes was observed. The red blood cell count was 1.83 million; hemoglobin 3.5 gm., reticulocytes 7 per cent; platelet count 459,000; and the white blood cell count 12,100. The bleeding and coagulation time was normal. A peripheral blood smear showed moderate hypochromia. The red blood cell fragility test was normal, the Coombs' test negative. Spinal bone marrow aspiration on July 6, 1953 showed erythroid hyperplasia. Chest roentgenograms on July 8, 1953 (Fig. 1 and 2) showed accentuation of pulmonary markings with "snow-storm or sand-storm" appearance of the perihilar lung fields. The costophrenic angles and apical lung fields were clear. The cardiac silhouette was normal and there was no evidence of hilar lymphadenopathy. The diagnoses suggested roentgenographically were miliary tuberculosis, sarcoidosis, lymphangitic carcinomatosis and fungus disease. Following blood transfusions and administration of ferrous sulfate, hemoglobin on July 20, 1953, was 12.1 gm. and hematocrit 41 mm. The patient ran a very low grade temperature the first five days of hospitalization but remained afebrile after the severe anemia was corrected.

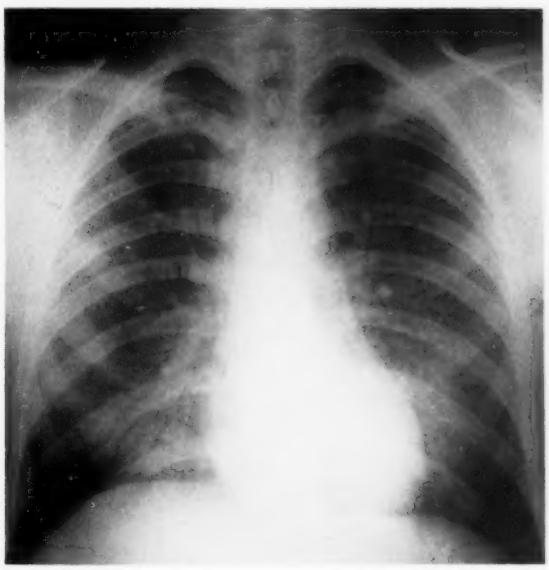

Fig. 1. July 8, 1953: Chest roentgenogram on first admission. Mottled densities on a homogeneous "grainy" background of fine speckling are seen in the right and left perihilar mid and lower lung fields. No evidence of hilar lymphadenopathy or of cardiac shadow abnormality.

Fig. 2. July 8, 1953: Magnified view of right mid and lower lung field perihilar infiltrates.

The purified protein derivative and histoplasmin skin tests were negative. The final clinical diagnosis was hypochromic anemia, microcytic, due to chronic blood loss. The site of bleeding was undetermined.

A chest roentgenogram on July 14, 1953, (Fig. 3) showed remarkable clearing of the bilateral pulmonary infiltrates with some small residual densities of a mottled homogeneous nature.

Following hospital discharge, the patient was examined periodically. Hemoglobin and hematocrit remained normal until the second admission on January 13, 1958, at the age of twenty-six. He complained of weakness, easy fatigability associated with "blinding spells," a feeling of "light-headedness" and moderate dyspnea, more marked on exertion, of six months' duration. One and one-half months prior to this admission, he developed a pro-

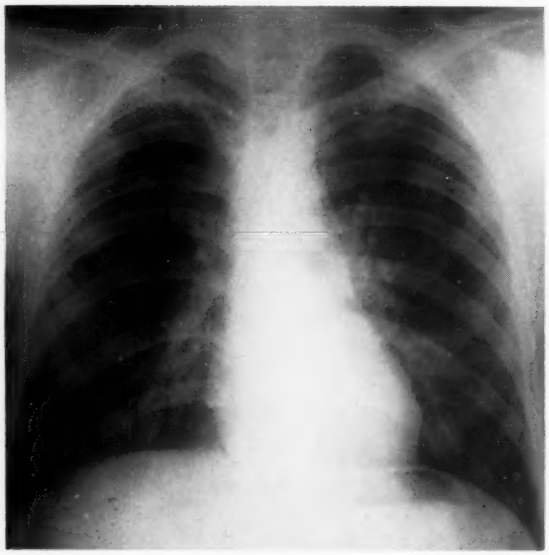

FIG. 3. July 14, 1953: Roentgenogram shows remarkable clearing of the bilateral pulmonary infiltrates, six days following admission.

ductive cough and hemoptysis of one-half cup daily associated with fever. The hemoptysis persisted until the time of admission. No hematemesis, jaundice, hematuria, or melena were observed.

On physical examination, January 13, 1958, the blood pressure was 122/56. He was well nourished, alert and in no distress. The lungs were resonant with no dullness but some questionable rales at the bases. The heart was not enlarged; the rhythm was regular and no murmurs were heard.

The hemoglobin was 9.8 gm., the red blood cell count 3.9 million and the white blood cell count 7,700 with 63 segmented, 1 band, 35 lymphocytes and 1 eosinophil. The reticulocyte count was 11.4 per cent and the platelets adequate. The serum bilirubin was 0.8 mg. per cent.

Chest roentgenograms on January 13, 1958, (Fig. 4 and 5) showed, as on July 8, 1953, very small nodular infiltrates in both perihilar lung fields, superimposed on a homogeneous, finely granular background. These involved the mid and lower lung fields, widely extending toward the lateral zones, but not the supradiaphragmatic, costophrenic and apical lung fields. The heart borders and pulmonary vascular shadows were moderately obtunded by these densities. No evidence of cardiac enlargement was observed. The impression was that granulomatous angiitis was to be considered as well as idiopathic pulmonary hemosiderosis or pulmonary

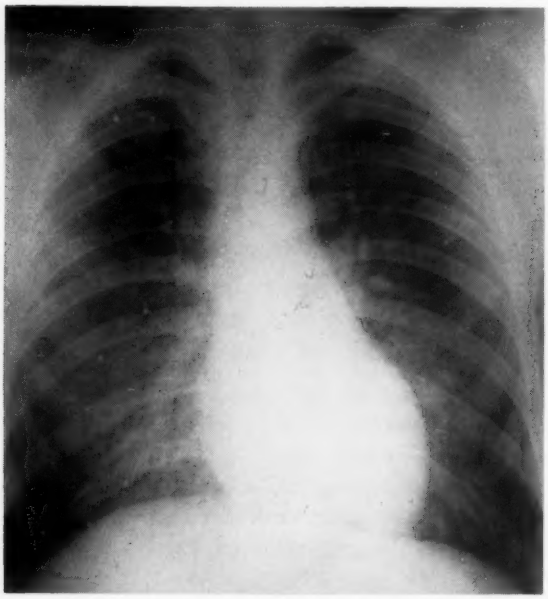

FIG. 4. January 13, 1958: Roentgenogram on second admission. The perihilar, mid and lower lung fields again present small, fine focal infiltrates, superimposed on a homogeneous, granular background. Note the clear peripheral lung zones with sparing of the supradiaphragmatic and apical lung fields.

FIG. 5. January 13, 1958: Magnified view of right mid and lower perihilar areas.

hemorrhagic disease, in view of the episodes of hemoptysis and the anemia. Bronchiectasis or a bronchial adenoma also could not be ruled out. Sputum cultures showed a heavy growth of pneumococci. Repeated smears for acid-fast bacilli were negative. A chest roentgenogram on January 16, 1958 showed moderate but definite clearing of infiltrates in the infraclavicular lung fields and persistency of finely stippled and mottled densities in either lower perihilar and right mid-perihilar zones. On the same date bone marrow biopsy revealed normal megakaryocytes and fairly marked erythroid hyperplasia. An upper gastrointestinal series was normal. On January 21, 1958, bronchial washings showed the presence of macrophages containing hemosiderin, giving Prussian blue reaction with potassium ferrocyanide. The stools were negative for occult blood. A chest roentgenogram on February 3, 1958, disclosed new infiltrates, in addition to the residual left perihilar and infraclavicular very small nodular densities seen on January 16 and 24, 1958 (Fig. 6). Recent increased opacities of the right and left perihilar lung fields, not involving the apical and costophrenic angle areas, were noted. On February 3, 1958, the hemoglobin was 9.5 gm., hematocrit 32 while the platelets were adequate. A bronchogram on February 19, 1958, was normal.

Fig. 6. January 24, 1958: Roentgenogram shows moderate but definite clearing of the infiltrates with persistence of small nodular densities in the right mid and lower perihilar and left lower lung fields.

The patient was asymptomatic during the major part of his hospital stay. He continued to have a mild degree of hemoptysis daily. When allowed to go home in February, he developed fever and increased hemoptysis; a repeat chest roentgenogram showed an increase in reticulated markings of the lung fields. An associated drop in hemoglobin and hematocrit took place, signalling a typical exacerbation of pulmonary bleeding. A chest roentgenogram on March 24, 1958, revealed marked clearing of either perihilar and left infraclavicular densities with suggestion of a reticulostriate pattern in both mid and lower lung fields.

On re-hospitalization, March 25, 1958, the hemoglobin was 12.6 gm., hematocrit 42, sedimentation rate 15 mm. and platelets adequate. The reticulocyte count was 2 per cent. The serum iron was 15 gamma; the iron binding capacity was 300. On April 4, 1958, by open thoracotomy, a lung biopsy was performed. Several special stains including PAS for elastic connective tissue were prepared. A large number of intra-alveolar macrophages filled with iron were seen. The elastic fibers of the alveolar walls and elastic lamina of the arterioles were not impregnated with hemosiderin and showed no evidence of fragmentation or degeneration. A few macrophages contained small PAS granules. Pathologic diagnosis: Entirely compatible with idiopathic pulmonary hemosiderosis. (Dr. Joseph Mendeloff;* reviewed by Dr. Averill A. Liebow.†)

A chest roentgenogram on May 6, 1958, showed focal pleural thickening over the left pericardial lung field with adhesions of the left diaphragm (postsurgical). The pulmonary reticular markings persisted. Almost complete resorption of residual perihilar pulmonary densities was noted.

On September 29, 1958, the hemoglobin was 16.6 gm., the white blood cell count 7,750, platelets adequate and the hematocrit 49 mm. On January 20, 1959, he was re-admitted to the hospital because of moderate dyspnea and a cough productive of yellow sputum. The hemoglobin was 16.0 gm. A chest roentgenogram on April 6, 1959, showed no change in the appearance of the lung fields since May, 1958. He was discharged after one day of observation.

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CLINICAL DATA

The clinical course of idiopathic pulmonary hemosiderosis is typical and suggests the diagnosis to the clinician who is aware of the syndrome. The patient suffers from shortness of breath, headache, fatigability, intermittent fever, striking pallor and hemoptysis. A persistent cough is noted. Very often with continuation of the illness over a month, cyanosis, and sometimes abdominal pain and nausea, accompany the acute exacerbation of the disease. The acute symptoms may last variably from several hours to several days and subside slowly. In the interval, the patient is symptom-free for several weeks or months except for general weakness and pallor. In most cases the numerous infiltrations seen on the chest roentgenogram, obtained during the acute episode, are in striking contrast to the minimal physical findings of the chest. A few cases in the more chronic patients[2,3] were reported as having enlargement of the liver and spleen. A slight degree of jaundice with serum bilirubin up to 2.0 mg.[15,18] may be found, often of short duration, due to absorption of hemoglobin pigment from the pulmonary alveoli. The urinary urobilinogen test was positive in 3 adult cases in the literature.[2] In the later stages of the disease, the dyspnea and tachycardia continue to harass the patient; pallor and weakness are augmented; hemoptysis and often hematemesis are observed. The signs of pulmonary fibrosis and cor pulmonale are now found with cyanosis, orthopnea and clubbing of the terminal phalanges.

LABORATORY FINDINGS

The disease is characterized by a hypochromic, microcytic anemia, the hemoglobin characteristically varying from 2 to 7 gm.

The bone marrow is usually not remarkable or shows erythroid hyperplasia. The serum iron is characteristically low, ranging from 27–75 gamma[10,16,25,36] in all the reported cases in which this finding is indicated. The iron fixation capacity is usually high, ranging from 300–400 gamma.[16]

Instances of erythrocytosis, temporarily or spontaneously appearing, were noted in a few cases[18,21,32,46,50] in which the number of erythrocytes at varying periods in the clinical course ranged up to 6.7 million,[18] 5.7 million and 5 million.[32] The hemoglobin determinations sometimes during the clinical course were at levels of 100 to 125 per cent in these cases, although it was more characteristically abnormally low at other periods in the clinical course of the same patients; then the red blood cell count ranged from 2–3 million. Halmagyi *et al.*[18] noted that, although the erythrocytes rose to 6.7 million and the hemoglobin to 16.0 gm. per cent in their case, the serum iron never surpassed 50 gm. per cent. Our patient presented a hemoglobin of 16 gm. per cent over the last several months up to the time of writing, but with a low serum iron. The severe derangement in the mechanism of compensatory oxygen diffusion must be the basis for the compensatory erythrocytosis. The determination of arterial saturation in Meyer's[32] patient as 77 per cent before and 93.1 per cent after inhalation of oxygen would substantiate this mechanism.[15]

The most important diagnostic laboratory finding is that of hemosiderin laden macrophages in the sputum or in the fasting morning gastric aspiration.[23]

SEX, AGE AND INCIDENCE

The youngest age at which the diagnosis of idiopathic pulmonary hemosiderosis was made in the adult cases reviewed was ten years,[10] while the oldest, in a case diagnosed at autopsy, it was fifty-three years. The majority of clinical diagnoses was established in the second and third decades. In 6 of the adult cases the symptoms began after thirty years of age, the oldest being forty-seven. A preponderance of males was found: 27 males to 11 females among these adults. In the children a preponderance of females, 23 to 17, has been noted by Wyllie *et al.*[54] and, also, by Joseph *et al.*[25] Soergel[43]

in his review of 81 cases of both adults and children found the sex distribution about even.

ANALYSIS OF ROENTGENOGRAPHIC FINDINGS

In 5 cases from the literature, insufficient or no descriptive roentgenographic data are presented by the authors. The following data were obtained from the initial chest roentgenograms of the symptomatic patients: of 32 cases (including the author's) in which the findings on the first chest roentgenograms were indicated, 20 patients, or approximately 62 per cent, showed positive or abnormal intrathoracic findings.

Twelve cases showed no roentgenographic abnormalities on the first medical observation or hospital admission but eventually did after intervals varying from nineteen days to three years; in 2 instances the abnormalities did not appear until after four and one-half to five years. Ten of the 12 cases later showed characteristic pulmonary infiltrates. One of the 12, a fatal case,[46] followed roentgenographically for eleven months showed no pulmonary abnormalities, while another developed, after one year, right midlung field infiltrates.[31] Thus, 33 cases of the 34 in which the roentgenographic appearance is described in the literature (including the author's case) showed abnormal intrathoracic findings.

In 6 of 34 adults, hilar lymphadenopathy was visualized on roentgenograms and proved by necropsy to be present in 3 cases, and not actually present in one case.[4,21,42,50] In only 4 out of 46 reported cases of children was hilar prominence or lymphadenopathy suggested by the radiologist in his readings.[25] This was associated with diffuse pulmonary infiltrates in all cases except one.[9,33,40,41] In 2 of these 4 cases that expired,[40,41] no hilar lymphadenopathy was found on necropsy. This infrequency of hilar lymphadenopathy in children and adults would appear to be an important differential diagnostic consideration, especially with regard to miliary tuberculosis in children and sarcoidosis in adults.

Typical Pattern. Twenty-nine adults showed the characteristic bilateral, very small nodular infiltrates, often described as "diffuse, fine grainy," or "ground-glass infiltrates" or again "fine stippling," usually preferring the perihilar and lower lung fields or bases, in which latter position the infiltrates are of maximal density.[14,22] The apical and supradiaphragmatic lung fields, although usually spared, may also on occasion be the site of infiltrates. The greatest intensification of these densities takes place typically during the clinical attack or exacerbation and shows partial and even complete clearing during the periods of clinical recovery.[11] The infiltrates may vary from a few millimeters to 2–3 cm. in diameter and there is a great variation in the number of focal densities. The diffuse homogeneous type of shadows seen during an acute attack or acute phase of the disease often gives way, during the remissions, with clearing of the air spaces by macrophages, to the reticulostriate pattern which is indistinguishable from interstitial granulomatosis or fibrosis; however, the reticulostriate pattern has also been noted at the onset of the acute phase of the disease.[22] In the overwhelming majority of cases reported in infants and children, the bilateral small nodular infiltrates did not differ in any perceptible way in their size, configuration and distribution from those described in adults.[25] In only one instance, that of an adult,[48] was a small pleural effusion noted, on the left side.

Atypical Pattern. In 4 reported adult cases, the pulmonary infiltrates were large, confluent and dense and decreased in density toward the hili. In the case of Matzel,[31] unilateral infiltrates were seen in the right midlung field. Iwanow[24] reported unilateral densities which disappeared rapidly; whereupon, fourteen days later, densities appeared in the contralateral lung field. Again, Herzog[21] described widened and dense hili which increased in size throughout the years with no perihilar or

pulmonary infiltrates (Scheidegger and Dreyfus[40]).

The pulmonary infiltrates in all cases vary in size and are resorbed partially or even completely with clinical remissions in the majority of cases usually after eight to fourteen days or after several weeks, or even after four months.[3] Then they typically recur with clinical exacerbations of the disease. Nevertheless, in some cases the initially observed pulmonary infiltrates persisted without alteration during a period varying from a few months to four years in the presence of successive remissions and exacerbations;[23,29,30,32,37,39] or the infiltrates disappeared initially in one reported case after a few weeks only to reappear and then remain unchanged during two years of observation. It is apparent that wide variations are found in the schedule of appearance and disappearance of the infiltrates from one adult to another and in the same individual. In the author's case, the pulmonary infiltrates showed evidence of resorption after six days in July of 1953, while comparison of the chest roentgenograms of January 13 and 16, 1958, revealed definite clearing of infiltrates in the upper lung fields and infraclavicular zones, but persistence of densities in either lower lung field. Thus, a selective resorption of the infiltrates in a portion of the lung fields had taken place over a period of only four days. It was not, however, until March 24, 1958, that a chest roentgenogram showed marked clearing of either perihilar and infraclavicular densities with the appearance of a reticulostriate pattern in both mid and lower lung fields. The chest roentgenogram of April 6, 1959, revealed no remarkable change in the fine reticulostriate markings in the right and left midlung fields or in the still faintly persistent fine granular densities.

PROGNOSIS

Only 13 of 34 adult cases were reported as alive at the time of writing. These were experiencing bouts of hemoptysis, fever and dyspnea, recurring at intervals usually of a few months.[23,36] In the collected cases, the longest duration of the clinical course from the onset of typical symptoms and signs was eighteen years[2] (during which period the patient was actually in symptom-free remission, following which death ensued) and twenty years,[21] respectively. The latter case, however, presented severe debilitating exacerbations throughout the extended course of his disease. Death may ensue rapidly. In 2 reported cases the patients died of massive pulmonary hemorrhage after one and one-half and three months of a mild clinical course and after only fourteen and eighteen hours of medical observation.[7,42]

In the chronic form of the disease, as is noted in Table 1, the patient dies on the average after three and one-half years of pulmonary infection. Of those adults surviving at the time of the report, 3 cases[30,39] had lived four years and 2 cases had lived six years.[3]

PATHOGENESIS

Extensive changes noted in elastic fibers of the lungs at necropsy in many cases[6,49] suggested in the earlier conception of the disease process that the primary defect was that of the elastic tissues. However, it would appear that these changes are the result rather than the cause of hemosiderosis and that the degree of elastic tissue damage is proportional to the duration of the disease.[34,44] In those cases with a short or acute clinical course followed by death, one does not find any excessive incrustation with hemosiderin or degeneration of the elastic tissues.[19,42] Although the clinical course of the disease was of six years' duration in the author's case, no elastic tissue destruction was observed. Steiner[44,45] proposed that the permeability of the pulmonary capillaries is altered by an antigen antibody reaction in an "auto-sensitized" person and introduced the concept of auto-immunization. He considers the spleen to play a role in this auto-sensitization as a member of the reticuloendothelial system responsible for antibody production. The lungs react as the shock organ.

Ferguson *et al.*[13] suggested that intra-

TABLE I

CASES OF IDIOPATHIC PULMONARY HEMOSIDEROSIS IN ADULTS

Author	Sex	Method of Diagnosis	Age at Onset of Symptoms (yr.)	Age at Diagnosis (yr.)	Follow-up after Diagnosis	Clinical Result	Abnormal First Chest Roentgenogram	Roentgenographic Findings
Borsos-Nachtnebel[1] (1942)	M	Roentgenology and Necropsy	Not stated	38	None	Dead	Not indicated	Not indicated
Waldenström[49] (1944)	F	Roentgenology and Necropsy	16	16	2 yr. and 8 mo.	Dead	Yes	Diffuse, bilateral, pulmonary mottling with very small opacities. Resorption of infiltrates after 8 days
Shanks and Kerley[39] (1951)	M	Roentgenology	Not stated	20–30	Not stated	Not stated	Not indicated	Not indicated
	M	Roentgenology	Not stated	20–30	Not stated	Not stated	Not indicated	Not indicated
	F	Roentgenology	Not stated	20	Not stated	Not stated	Yes	Routine chest roentgenogram. No description of infiltrates
	M	Roentgenology and Biopsy	Not stated	19	Not stated	Not stated	Not indicated	Miliary infiltrates
	M	Roentgenology	Not stated	28	4 yr.	Living	Not indicated	Miliary infiltrates unaltered over a period of 4 years
Walton and Williams[50] (1951)	M	Roentgenology and Necropsy	16	17	2 yr.	Dead	No	Normal at 16; at 18 years, wide-spread ground-glass mottling; enlarged hili. Slight cardiac enlargement
Tait and Corridan[46] (1952)	M	Necropsy	31	?31	None	Dead	No	All chest roentgenograms normal
Cliff[8] (1953)	M	Roentgenology	20	20	2 yr. and 9 mo.	Living	Yes	Mottling over mid-zones, both lungs; more on right. Clearing of lung fields except for residual haziness in right middle zone which disappeared in 21 days
Herzog[21] (1954)	M	Necropsy	6	26	None	Dead	Yes	At age 15 widened, thickened, dense hili appeared which increased in size progressively throughout the years
Manderson[30] (1954)	M	Roentgenology	18	19	4 yr.	Living	Yes	Fine grainy appearance of mid- and basal zones, both lungs, apices being clear. Normal cardiac shadow. No hilar lymphadenopathy
Sandøe[36] (1954)	F	Roentgenology	9	19	6 yr.	Dead	No	First chest roentgenogram at age 13. At age 19, faint infiltrates in right base which cleared after 3 weeks. Subsequently bilateral, very small, nodular infiltrates appeared and persisted for 4 years
	M	Roentgenology	13	?15	1 yr.	Living	No	Bilateral, very small, nodular infiltrates, abundant at bases
Hamer[19] (1955)	M	Roentgenology	13	19	Few mo.	Living	No	Not until 4½ years later, with an acute exacerbation, chest roentgenogram showed miliary mottling throughout both lung fields, maximal in middle zones
Wagner[48] (1955)	F	Roentgenology	21	22	3 yr.	Dead	No	After 2 years, large confluent dense, bilateral infiltrates appeared with hazy margins decreasing in den-

(*Continued on following pages*)

TABLE I—(*Continued*)

Author	Sex	Method of Diagnosis	Age at Onset of Symptoms (yr.)	Age at Diagnosis (yr.)	Follow-up after Diagnosis	Clinical Result	Abnormal First Chest Roentgenogram	Roentgenographic Findings
								sity toward the hili. Large areas of clear lung fields. Small pleural effusion on left. No change over a period of 12 months
Gluck[17] (1955)	M	Necropsy	15	15	2 yr.	Dead	Yes	Numerous generalized, small, patchy infiltrates. Variations in size with clinical exacerbations and remissions
Chatgidakis[7] (1955)	F	Necropsy	47	47	14 hr.	Dead	Yes	Soft, rounded opacities scattered throughout both lung fields, slightly more marked in perihilar areas
Meyer[32] (1955)	M	Roentgenology	18	20	3 mo.	Living	Yes	Extensive bilateral lower lung field densities which completely disappeared in a few weeks. Later miliary densities appeared and persisted for 2 years
Halmagyi *et al.*[18] (1956)	M	Roentgenology and Biopsy	38	39	1 yr.	Living	Yes	Numerous perihilar small nodular infiltrates and fine linear reticular markings
Scadding[37] (1956)	F	Roentgenology and Necropsy	40	44	None	Dead	Yes	Dense, diffuse, fine stippling in perihilar and lower lung fields which cleared 12 months later; recurrence of basilar and perihilar infiltrates with subsequent attacks
Wynn-Williams and Young[55] (1956)	M	Roentgenology and Biopsy	28	29	Few mo.	Living	Yes	Fine nodular stippling over the lower half of each lung field
Bruwer *et al.*[4] (1956)	M	Roentgenology and Necropsy	16	18	3 yr.	Dead	Yes	Enlargement of hilar shadows. Frosted glass appearance of perihilar and basal regions
Könn[26] (1956)	F	Necropsy	52	53	None	Dead		Data not available
Florian[15] (1956)	F	Roentgenology	26	27	5 da.	Dead	Yes	Soft, cloudy densities in either perihilar lung field which became denser proceeding to lower lung fields. Apical fields not involved
Browning and Houghton[3] (1956)	F	Roentgenology and Necropsy	22	25	None	Dead	No	Nineteen days after hospital admission, infiltrates involved all lung fields except for part of left upper lobe
	M	Roentgenology	23	26	3 yr.	Living	Yes	Bilateral diffuse, miliary shadows varying from 1 to 3 mm. in diameter. Clearing of lung fields after one exacerbation in 7 weeks; another in 4 months
	M	Roentgenology and Necropsy	18	22	None	Dead	Yes	Bilateral granular perihilar infiltrates which cleared in varying intervals of time from 1 to 2 weeks
Leschke[29] (1957)	M	Necropsy	13	19	None	Dead	Yes	Small nodular infiltrates in both lung fields which persisted without resolution

TABLE I—(*Continued*)

Author	Sex	Method of Diagnosis	Age at Onset of Symptoms (yr.)	Age at Diagnosis (yr.)	Follow-up after Diagnosis	Clinical Result	Abnormal First Chest Roentgenogram	Roentgenographic Findings
Matzel[31] (1957)	F	Roentgenology and Necropsy	30	31	2 yr.	Dead	No	Positive findings appeared 1 year later with clinical anemia and hemoptysis. Soft nodular infiltrates in right midlung field
Doering and Gothe[10] (1957)	M	Roentgenology and Necropsy	7	10	7	Dead	No	Two years after clinical examination small nodular (kleinfleckige) foci appeared, especially prominent in the lower lung fields
Irvin and Snowden[23] (1957)	M	Roentgenology	14	15	1 yr.	Living	No	Later hilar lymph nodes enlarged, bilaterally. Diffuse finely mottled density throughout entire lung fields, more marked in central portions. Partial resolution of densities on right but persistence on left
Iwanow[24] (1958)	M	Biopsy	19	22	9 mo.	Living	Yes	Enlarged hili. Increased bronchovascular markings of lower lung fields. Unilateral pulmonary densities which rapidly disappeared. Fourteen days later similar densities in contralateral lung
Smith and Fienberg[42] (1958)	M	Necropsy	33	33	18 hr.	Dead	Yes	Diffuse, fine mottling throughout both lung fields, most marked at bases. Heart size normal. Apparent bilateral hilar enlargement; no lymphadenopathy found on autopsy, however
Boyd[2] (1959)	M	Roentgenology and Necropsy	19	37	1 mo.	Dead	No	At 27 years of age, fine miliary mottling of both mid and lower zones
	M	Roentgenology and Necropsy	33	33	3 yr. and 7 mo.	Living	Yes	Miliary stippling throughout both lung fields, less marked at apices and bases. Marked clearing in 7 months
	F	Roentgenology	14	19	3 mo.	Living	No	At 19 years of age, 5 years after first chest roentgenogram, fine, stippled opacities appeared throughout both lung fields, but mainly in the mid and lower zones. Incomplete clearing after six weeks
Bronson (1959)	M	Roentgenology	21	27	1 yr. and 5 mo.	Living	Yes	Bilateral perihilar and lower lung field, finely stippled infiltrates which cleared in 6 days (1953). Six years later, similar infiltrates appeared which cleared in the upper lung fields after 4 days but persisted in lower perihilar areas; then 11 days later, new perihilar infiltrates manifest which almost completely cleared in 21 days. Reticulostriate densities now in either lung field

pulmonary hemorrhage stems from anastomoses present between the pulmonary arterial and the bronchial tree so that these vessels, following elevated pressure in the pulmonary artery, become congested, varicosed and widened, similar to the varices in portal hypertension. Lendrum *et al.*[28] believe that the diapedesis into the alveoli is due to congestion in the collaterals between the pulmonary artery and bronchial vascular tree. These theories presume that marked pulmonary hypertension exists as is true for the origin of pulmonary hemosiderosis in mitral stenosis, congenital heart anomalies or left ventricular insufficiency. However, despite this Meyer[32] found in a twenty year old patient by cardiac catheterization only a very minimally increased pulmonary artery pressure. In contradiction to the theory of Ferguson and coworkers[13] stands the fact that previous observers[12,18,27,36] did not find on cardiac catheterization any elevation of the pulmonary arterial pressure in 5 patients including 1 adult.[18] Therefore, elevated pulmonary arterial pressure is not a prerequisite for the origin of essential pulmonary hemosiderosis; nevertheless, markedly elevated pulmonary arterial pressure may and did appear later as a result of the primary disease, as was demonstrated by catheterization in one instance of an eleven year old boy.[18]

A new theory of the pathogenesis of idiopathic pulmonary hemosiderosis if that of Herzog.[21] He asserts, upon the basis of careful histologic investigations, that the essential nature of the disease is a proliferation or hyperplasia of the capillary argyrophil fibrils. He was able to demonstrate numerous tortuous or sinuous capillary proliferations about which there was an abnormal increase in the argyrophil reticular fibril network. Propst[35] showed increase in acid mucopolysaccharide (AMPS) within the elastic fibers of the small blood vessels and intra-alveolar walls, thereby weakening the elastic fibers. As a result, vascular dilatation and bleeding by diapedesis ensue. The liberated iron becomes impregnated on the elastic fibers since AMPS has a strong affinity for it. Propst[35] compares idiopathic pulmonary hemosiderosis with senile elastosis and states that it may be a form of arachnodactyly.

The hemotologic pattern is that of recurrent loss of blood in the absence of external hemorrhage associated with an increase in erythropoiesis. However, no defects in the blood clotting mechanism are observed. Wyllie *et al.*[54] suggest that cold agglutins, present in some cases in the acute attack, represent a secondary antibody response to the red blood cells destroyed. A positive Coombs' test is not generally found. A hemolytic process is very difficult to envisage as the etiology of this disease which is restricted to the lungs. The primary factor or defect in idiopathic pulmonary hemosiderosis is the change in permeability of the pulmonary capillaries resulting in alveolar hemorrhage. This hemorrhage later occasions the pulmonary fibrotic changes and, with the hemosiderin deposition, elastic tissue damage in the majority of cases that survive a sufficient number of years.

TREATMENT

Since the pathogenesis of idiopathic pulmonary hemosiderosis remains obscure, the treatment for the most part is supportive, consisting of iron therapy, blood transfusions and oxygen inhalation during the periods of remission. Antibiotics are employed in the acute stage for secondary infections when present.

In 4 cases of children in whom splenectomy had been carried out, 2 showed some improvement.[43] In a fifth instance, the patient died approximately seven years after splenectomy.[10]

The use of cortisone and ACTH has been reported in 6 cases.[3,23,36] A nineteen year old female was treated with 20 mg. prednisolone daily for fourteen days without roentgenographic or clinical amelioration.[2] Two children quoted by Soergel[43] showed no change. Browning and Houghton[3] administered 15 mg. ACTH by the slow drip

method over a period of eight hours daily to one of their cases and followed this after two weeks with 100 mg. cortisone daily for three months. The patient remained in satisfactory remission at the time of writing.

The efficacy of splenectomy as well as the employment of ACTH and cortisone for the treatment of idiopathic pulmonary hemosiderosis remains equivocal and further experience is necessary before a definitive evaluation can be made.

SUMMARY AND CONCLUSIONS

A case of idiopathic pulmonary hemorrhage in a twenty-seven and one-half year old male, observed for six years from onset of his disease, is described. The typical clinical and roentgenographic findings are discussed.

A preponderance of adult males to females in the ratio of 2.7 to 1 was reported. The seriousness of the prognosis in this disease is implicit in that 21 of 34 adult cases (in which survival data are available) were dead at the time of writing. The remaining 13 cases were alive for varying periods of one to six years (median 3.5 years) when reported.

All patients, of whom data were available, showed abnormal intrathoracic roentgenographic findings of pulmonary infiltrates except 1 case which was followed clinically and roentgenographically for eleven months to death.

It should be emphasized that the time interval over which the pulmonary infiltrates change is extremely variable. A negative chest roentgenogram on the first clinical observation of the symptomatic patient can be expected in about one-third of the cases and does not rule out idiopathic pulmonary hemosiderosis. Pulmonary infiltrates, although present initially in two-thirds of the cases, may appear as late as two and one-half to five years following onset of the clinical symptoms but usually occur within nineteen days to two and one-half years.

Hemoptysis, anemia of 2 to 7 gm. hemoglobin (microcytic and hypochromic), persistent low serum iron and macrophages in the sputum containing hemosiderin are almost diagnostic of this disease. However, it is pointed out that erythrocytosis may be seen intermittently in a patient who also presents, alternatively in his clinical course, a very low hemoglobin or red blood cell count.

The radiologist has a unique opportunity and an important role in the diagnosis of this disease, if he is aware of the clinical aspects as he evaluates the chest roentgenogram. Although the list of differential diagnoses is impressive, careful scrutiny of the infiltrates, their distribution and variance in time, as well as the clinical laboratory data will facilitate the correct diagnosis. In 29 out of 34 collected cases, the radiologist was able to suggest the diagnosis of idiopathic pulmonary hemosiderosis.

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REFERENCES

1. Borsos-Nachtnebel, O. Zur Pathologie der Lungenhaemosiderose. *Zentralbl. d. allg. Path.*, 1942, *79*, 174–175.
2. Boyd, D. H. A. Idiopathic pulmonary haemosiderosis in adults and adolescents. *Brit. J. Dis. Chest*, 1959, *53*, 41–51.
3. Browning, J. R., and Houghton, J. D. Idiopathic pulmonary hemosiderosis. *Am. J. Med.*, 1956, *20*, 374–382.
4. Bruwer, A. J., Kennedy, R. L. J., and Edwards, J. E. Recurrent pulmonary hemorrhage and hemosiderosis: So-called idiopathic pulmonary hemosiderosis. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., 1956, *76*, 98–107.
5. Burckhardt, D., and Vogel, C. Ein Beitrag zur idiopathischen Lungenhämosiderose. *Monatsschr. Kinderh.*, 1955, *103*, 455–460.
6. Ceelen, W. Die Kreislaufstörungen der Lungen. In: Henke, F., and Lubarsch, O. Handbuch der speziellen pathologischen Anatomie und Histologie. Vol. 3. Springer-Verlag, Berlin, 1931, pp. 20–24.
7. Chatgidakis, C. B. Primary pulmonary haemosiderosis (Ceelen's disease); report of forty-seven year old woman. *South African J. Lab. & Clin. Med.*, 1955, *1*, 166–177.

8. CLIFF, J. M. Idiopathic pulmonary haemosiderosis. *Brit. J. Radiol.*, 1953, *26*, 102–104.
9. CORDEIRO, M. Un cas d'hémosidérose pulmonaire idiopathique guéri par splénectomie. *Helvet. paediat. acta*, 1953, *7*, 501–507.
10. DOERING, P., and GOTHE, H. D. Die idiopathische Lungenhämosiderose, klinische Beobachtungen und radiologische Untersuchungen mit Eisen 59 bei einem 17 jährigen Patienten. *Klin. Wchnschr.*, 1957, *35*, 1105–1112.
11. ELGENMARK, O., and KJELLBERG, S. R. Hemosiderosis of lungs—typical roentgenological findings. *Acta radiol.*, 1948, *29*, 32–36.
12. ELLMAN, P., and GEE, A. Pulmonary haemosiderosis. *Brit. M. J.*, 1951, *2*, 384–390.
13. FERGUSON, F. C., KOBILAK, R. E., and DIETRICK, J. E. Varices of bronchial veins as source of hemoptysis in mitral stenosis. *Am. Heart J.*, 1944, *28*, 445–456.
14. FLEISCHNER, F. G., and BERENBERG, A. L. Idiopathic pulmonary hemosiderosis. *Radiology*, 1954, *62*, 522–526.
15. FLORIAN, J. Zur Klinik der idiopathischen Lungenhämosiderose der Erwachsenen. *München. med. Wchnschr.*, 1956, *98*, 1597–1600.
16. CELLIS, S. S., REINHOLD, J. L. D., and GREEN, S. Use of aspiration lung puncture in diagnosis of idiopathic pulmonary hemosiderosis. *A.M.A. J. Dis. Child.*, 1953, *85*, 303–307.
17. GLUCK, E. Idiopathic pulmonary hemosiderosis; report of case with special regard to pathogenesis. *Acta path. et microbiol. scandinav.*, 1955, *37*, 241–251.
18. HALMAGYI, D. *et al.* Der kleine Kreislauf bei essentieller Lungenhämosiderose. *Ztschr. Kreislaufforsch.*, 1956, *45*, 40–47.
19. HAMER, N. A. J. Idiopathic pulmonary haemosiderosis in young adult. *Brit. M. J.*, 1955, *1*, 1008–1009.
20. HAUBRICH, R., and VERSEN, E. Über die miliäre Lungenhaemosiderose im Röntgenbild. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1944, *81*, 346–354.
21. HERZOG, G. Zum Wesen der sogenannten idiopathischen Hemosiderosis Pulmonum. *Ber. d. Oberhess. Ges. f. Natur u. Heilkunde, Naturw. Abtlg.*, Bd. 27, Giessen, 1954, 199–214.
22. HODSON, C. J., FRANCE, N. E., and GORDON, I. Idiopathic juvenile pulmonary haemosiderosis. *J. Fac. Radiologists*, 1953, *5*, 50–61.
23. IRVIN, J. M., and SNOWDEN, P. W. Idiopathic pulmonary hemosiderosis; report of case with apparent remission from cortisone. *A.M.A. J. Dis. Child.*, 1957, *93*, 182–187.
24. IWANOW, E. D. Über die Ätiologie und Pathogenese der essentiellen Lungenhämosiderose. *Folia haemat. Frankf.*, 1958, *2*, 111–138.
25. JOSEPH, R., JOB, J. C., and GENTIL, C. L'hémosidérose pulmonaire. *Arch. franç. pédiat.*, 1958, *14*, 36–70.
26. KÖNN, G. Die pathologische Morphologie der Lungengefässe bei chronischem Cor pulmonale (ein Beitrag zur Ätiologie und zu den Folgen der chronischen pulmonalen Hypertonie). *Beitr. path. Anat.*, 1956, *116*, 273–329.
27. LAUBRY, C., LENEGRE, J., and ABBAS, L. Contribution à l'étude des opacités pulmonaires radiologiques du type micronodulaire; l'hypertension artérielle pulmonaire. *Bull. et mém. Soc. méd. d. Hôp. de Paris*, 1948, *64*, 741–749.
28. LENDRUM, A. C., SCOTT, L. D. W., and PARK, S. D. S. Pulmonary changes due to cardiac disease with special reference to haemosiderosis. *Quart. J. Med.*, 1950, *19*, 249–262.
29. LESCHKE, W. Beitrag zur Pathogenese der essentiellen Lungenhaemosiderose. *Beitr. path. Anat.*, 1957, *117*, 315–330.
30. MANDERSON, W. C. Idiopathic pulmonary haemosiderosis with report of case in adult. *Glasgow M. J.*, 1954, *35*, 19–24.
31. MATZEL, W. Idiopathische Lungenhaemosiderose bei einer Erwachsenen. *Deutsche med. Wchnschr.*, 1957, *82*, 2194–2196.
32. MEYER, K. Ein Beitrag zur idiopathischen Lungenhämosiderose. *Ärztl. Wchnschr.*, 1955, *10*, 583–586.
33. MUNDT, E. Die Begleitreticulose oder Réticulose associée. (Dargestellt am Beispiel einer eosinophilen allergischen Dermatose und der progressiven pneumohämorrhagischen Anämie.) *Deutsches Arch. klin. Med.*, 1951, *198*, 11–21.
34. NANCEKIEVILL, L. Acute idiopathic pulmonary haemosiderosis. *Brit. M. J.*, 1949, *1*, 431–433.
35. PROPST, A. Morphologie und Pathogenese der essentiellen Lungenhämosiderose. *Arch. path Anat.*, 1955, *326*, 633–663.
36. SANDØE, E. Essential pulmonary haemosiderosis; account of 2 cases, 1 treated experimentally with ACTH. *Danish M. Bull.*, 1954, *1*, 175–179.
37. SCADDING, J. G. Pulmonary fibrosis and collagen diseases of lungs; symposium. I. Clinical problems of diffuse pulmonary fibrosis. *Brit. J. Radiol.*, 1956, *29*, 633–641.
38. SCHAAR, F. E., and RIGLER, L. G. Idiopathic pulmonary hemosiderosis; essential brown induration of lung; report of case and review of literature. *Journal-Lancet*, 1956, *76*, 126–134.
39. SHANKS, S. C., and KERLEY, P., Editors. A Textbook of X-Ray Diagnosis, by British Authors. Second edition. Volume II. W. B. Saunders Company, Philadelphia, 1951, pp. 178–181.
40. SCHEIDEGGER, S., and DREYFUS, A. Braune Lungen Induration des Kindes mit sekundärer Anämie. *Ann. paediat.*, 1945, *165*, 2–11.

41. Schoeniger, E. L., Tucker, A. S., and Bolande, R. P. Idiopathic pulmonary hemorrhage with hemosiderosis and microcytic anemia. *Radiology*, 1958, *70*, 191–195.
42. Smith, W. E., and Fienberg, R. Early nonrecurrent idiopathic pulmonary hemosiderosis in adult; report of case. *New England J. Med.*, 1958, *259*, 808–811.
43. Soergel, K. H. Idiopathic pulmonary hemosiderosis; review and report of 2 cases. *Pediatrics*, 1957, *19*, 1101–1108.
44. Steiner, B. Die essentielle pulmonale Hämosiderose als immunohämatologisches Krankheitsbild. *Acta. med. Acad. sc. Hung.*, 1954, *6*, 79–82.
45. Steiner, B. Essential pulmonary haemosiderosis as immunohaematological problem. *Arch. Dis. Childhood*, 1954, *29*, 391–397.
46. Tait, G. B., and Corridan, M. Idiopathic pulmonary haemosiderosis. *Thorax*, 1952, *7*, 302–304.
47. Virchow, quoted by Ceelen.[6]
48. Wagner, K. Isolierte progrediente Lungenhämosiderose; Beitrag zur Differential Diagnose hypochromer Anämien. *Medizinische*, 1955, *3*, 117–118.
49. Waldenström, J. Relapsing, diffuse pulmonary bleedings or hemosiderosis pulmonum—new clinical diagnosis. *Acta radiol.*, 1944, *25*, 149–162.
50. Walton, M., and Williams, A. A. Idiopathic pulmonary haemosiderosis; report of case in adult. *Brit. M.J.*, 1951, *2*, 390–391.
51. Weingärtner, L. Zur Frage der idiopathischen Lungenhämosiderose; unter besonderer Berücksichtigung röntgenologischer Veränderungen. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1957, *87*, 482–487.
52. Wiesmann, W., Wolvius, D., and Verloop, M. C. Idiopathic pulmonary hemosiderosis. *Acta. med. scandinav.*, 1953, *146*, 341–345.
53. Wigod, M. Idiopathic pulmonary hemosiderosis; report of case in early childhood with severe anemia. *New England J. Med.*, 1955, *253*, 413–416.
54. Wyllie, W. G., Sheldon, W., Bodian, M., and Barlow, A. Idiopathic pulmonary haemosiderosis (essential brown induration of lungs). *Quart. J. Med.*, 1948, *17*, 25–48.
55. Wynn-Williams, N., and Young, R. D. Idiopathic pulmonary haemosiderosis in adult. *Thorax*, 1956, *11*, 101–104.

PATHOGNOMONIC SIGNS OF CHRONIC BRONCHITIS*

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ROENTGENOGRAPHICALLY, only a few plain film and bronchographic changes have been associated with chronic bronchitis. In the past, the diagnosis has been made solely on the basis of emphysema and peripheral fibrosis. Much of the basic work in the pathology and radiology of bronchitis has come from Great Britain. Recently, there has been renewed interest in chronic bronchitis in this country with publication of two papers, each reporting specific bronchographic findings in chronic bronchitis.[13,16]

We are reporting a case demonstrating both of these specific bronchographic findings: bronchial gland involvement and bronchiolectasis. This combination of features has not been demonstrated previously roentgenographically. A brief discussion is presented to clarify the present status of the roentgen diagnosis of chronic bronchitis.

REPORT OF A CASE

R.J., a thirty-three year old white male, entered the hospital with complaints of chest pain and cough productive of whitish and occasionally yellow sputum which he had had most of his life. He complained of gradually increasing bilateral chest pain over the twenty-four hour period prior to admission, aggravated by deep inspiration. The cough had recently become more productive. He denied hemoptysis.

The patient had smoked more than one package of cigarettes per day for fifteen years. He vaguely remembered several bouts of severe upper respiratory infections during childhood. The family history was noncontributory.

Physical examination revealed no significant chest abnormality.

Sputum cultures demonstrated normal flora and skin tests for acid fast bacilli, coccidioidomycosis, and histoplasmosis were negative as well as acid fast bacilli cultures and guinea pig inoculations. Pulmonary function studies demonstrated moderately advanced obstructive impairment. Bronchoscopy was negative. The bronchograms are shown in Figures 1–3.

The patient received no definitive therapy. The chest pain subsided in forty-eight hours, and the productive cough diminished.

DISCUSSION

Clinically, the diagnosis of chronic bronchitis is made on the basis of cough, excessive production of sputum, dyspnea, and following the exclusion of all other possibilities. The disease is most commonly found in middle aged to elderly males often with a strong family history of similar affliction.[8] The diagnosis is being established with increasing frequency in young adults because of more frequent use of bronchography.

To date, no studies have demonstrated the importance of cigarette smoking in producing roentgenographic changes. As in the studies implicating smoking as an etiologic factor in cases of bronchogenic carcinoma and emphysema, it is suggested that it may also be a contributing factor in the pathogenesis of chronic bronchitis.

The pathologic diagnosis of chronic bronchitis is based on several findings. There is hypertrophy of the mucus-secreting elements with excessive numbers of goblet cells, hypertrophy of the bronchial glands, and dilatation of the ducts due to secondary infection. These changes are responsible for the bronchographic findings described. It has been suggested that these dilated glands and ducts also act as foci for continued infection. Also seen are round cell infiltration of the bronchial mucosa, scarring, alternate narrowing and dilatation

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Fig. 1. (*A* and *B*) Arrows indicate areas of bronchiolectasis (bronchiolar diverticulosis) and bronchial gland involvement (bronchiolar adenolectasis). Note the otherwise normal bronchial tree. The thoracic configuration and lung fields suggest equivocal emphysema.

of the bronchi, and bronchiolectasis. Bronchiolectasis is characterized by cystic areas arising from the walls of terminal bronchi (Fig. 1–3). The walls of these cystic spaces are usually lined with respiratory epithelium and contain strands of muscle indicating a bronchiolar origin. Ulceration may be a factor, in addition to distention and infection, in producing these spaces. The chronic cough, associated with bronchitis, increases intrabronchial pressure which may dilate a weakened area of a bronchiole causing bronchiolectasis. Reid[10,11,12] has shown these cystic areas measuring 3–5 mm. in diameter arising from bronchioles 1 mm. in diameter.

In advanced cases there are purulent bronchiolitis, obliteration of the lumen, small foci of parenchymal consolidation, and abscesses. Abnormal amounts of mucus may be found in the alveoli suggesting that parenchymal involvement is disseminated by bacteria-laden mucin. The goblet cell hypertrophy and the bronchiolitis are reversible changes. The distortion of the ducts, the bronchial gland changes, and bronchiolectasis are permanent changes but variable in degree.

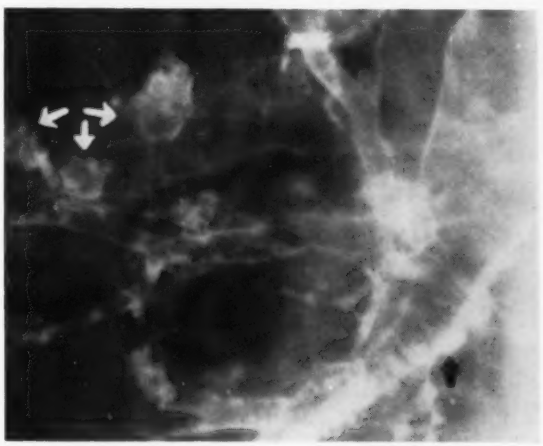

Fig. 2. Right hilar area from Figure 1*A* demonstrating primarily the cystic areas representing bronchiolectasis (bronchiolar diverticulosis). It also reveals a few dilated bronchial glands projecting from the inferior wall of the right main stem bronchus (×1.4).

FIG. 3. Left hilar area from Figure 1*B* demonstrating multiple dilated bronchial glands (bronchial adenolectasis) on the superior and inferior walls of both primary and secondary bronchial subdivisions (×1.9).

The use of bronchography has assisted greatly in establishing the diagnosis of chronic bronchitis. Several investigators have reported visualization of hypertrophied bronchial glands and dilated ducts by bronchography. This is analogous to visualization of the paraurethral ducts with contrast material in cases of urethritis. Bronchial gland visualization was first reported by Morlock and Pinchin[7] in 1933 when they described openings and depressions in the intercartilaginous depressions of the trachea and bronchi, but no such findings peripherally. Similar reports were made by Simon and Galbraith,[14] Gudbjerg and Thomsen,[4] and also Stutz, Steller and Fisher, as cited elsewhere.[13] These examiners found glandular involvement occurring peripherally and on the superior walls as well as the inferior walls of the bronchi. Review of a large series of bronchograms has revealed these ducts to be visualized in as high as 50 per cent of cases.[14,15]

Bronchiolectasis is a term which has been ascribed to the cystic changes of bronchioles. It is a logical assumption that the cystic spaces found roentgenographically are the same as the cystic changes noted by Reid.[10,11,12] Although postmortem confirmation is lacking in cases with bronchographic findings, these changes were found post mortem in cases with other criteria of chronic bronchitis, and have not been found associated with any other condition. Bronchiolectasis is an uncommon bronchographic finding. This may be due to the narrow diverticular neck making retrograde filling with contrast material difficult.

Bronchiolectasis usually appears in the upper lobe bronchi as out-pocketings from the secondary and tertiary bronchial subdivisions in contrast with saccular bronchiectasis, which usually appears in the lower lobes. Bronchiectasis is not found in cases of bronchiolectasis.

Wisoff[16] suggests that the findings in the 100 cases of larval bronchiectasis reported by Zorini and Pigorini[17] represent bronchiolectasis. Their visualization at bronchography of "peripheral pooling," "morula," and "ball or ink blot grouping" showed distorted peripheral alveolar-acinar groups, but these failed to fill with con-

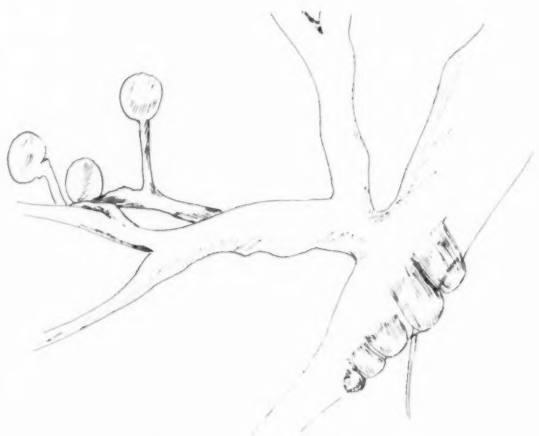

FIG. 4. Sketch of Figure 2.

trast material and seldom demonstrated hyperpneumatization. They did not describe or demonstrate a discrete air filled cystic structure coated by contrast material and communicating with a bronchus. Therefore, the requirements for the diagnosis of bronchiolectasis were not fulfilled.

To demonstrate further the confusion in this field, Azoulay, in 1924, described cystic changes and felt they were syphilitic aneurysms of bronchi. Simon and Galbraith[14] reported that 4 of 90 patients studied by bronchography showed cystic changes, which he attributed to tuberculosis. These changes may have represented bronchiolectasis, but cystic bronchiectasis of tuberculosis must be excluded in order to establish this diagnosis.

Since the cystic spaces termed "bronchiolectasis" have all the pathologic criteria of diverticula, we suggest that the term *bronchiolar diverticulosis*, the original name applied, be reinstated since it is more accurate and descriptive. In addition, since the latter term has unfortunately been applied to the glandular involvement described, we further suggest *bronchial adenolectasis* as a descriptive, proper term for the glandular facet of chronic bronchitis.

Fig. 5. Sketch of Figure 3.

Among other criteria for the roentgenographic diagnosis of chronic bronchitis is the alternate narrowing and dilatation of the bronchial lumen described as beading. There is also poor filling of small peripheral bronchi. Some cases show abnormal dilatation of the bronchi in both inspiration and expiration. A few cases reveal excessive, generalized inspiratory dilatation only, but more appreciable numbers show localized inspiratory dilatation. The routine chest roentgenogram usually reveals no definite abnormalities. Minimal peripheral peribronchial fibrosis and emphysema are occasionally noted. In a series of 857 patients with clinical evidence of chronic bronchitis, 15 per cent had equivocal evidence of emphysema, 37 per cent had some features of emphysema, and 48 per cent had no roentgenographic features of emphysema.[15]

Therefore, we can assume that the roentgen diagnosis of chronic bronchitis can best be made from the bronchographic findings with only minimal aid from the routine chest roentgenogram.

SUMMARY

The diagnosis of chronic bronchitis can be made with roentgenographic and bronchographic evidence of:

1. Bronchial gland dilatation (bronchial adenolectasis).
2. Bronchiolectasis (bronchiolar diverticulosis).
3. Distortion of bronchial walls with abnormal changes in caliber on inspiration and expiration.
4. Coincident emphysema and fibrosis.

The first two of the above manifestations are considered by the authors to be roentgenographically pathognomonic of chronic bronchitis. A case demonstrating both bronchiolar diverticulosis and bronchial adenolectasis has been presented.

Chronic bronchitis is a common problem, and the need for further investigation clinically, pathologically, and roentgenographically is definitely warranted.

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REFERENCES

1. BLADES, B., and DUGAN, D. J. Pseudobronchiectasis. *J. Thoracic Surg.*, 1944, *13*, 40–48.
2. DIRIENZO, S. Radiologic Exploration of the Bronchus. Charles C Thomas, Publisher, Springfield, Ill., 1949.
3. DUPREZ, A., and MAMPUYS, R. Cystic enlargement of mucous glands of bronchus associated with chronic bronchitis. *Thorax*, 1953, *8*, 141–147.
4. GUDBJERG, C. E., and THOMSEN, C. Inflammatory changes in bronchial glands in chronic bronchitis, demonstrated bronchographically. *Acta radiol.*, 1954, *42*, 269–275.
5. KNOTT, J. M. S., and CHRISTIE, R. V. Radiological diagnosis of emphysema. *Lancet*, 1951, *1*, 881–883.
6. LISTER, W. A. Chronic bronchitis; never complete diagnosis. *Lancet*, 1949, *1*, 719–721.
7. MORLOCK, H. V., and PINCHIN, A. J. S. Bronchial diverticulosis. *Lancet*, 1933, *2*, 236–237.
8. OSWALD, N. C., HAROLD, J. T., and MARTIN, W. J. Clinical pattern of chronic bronchitis. *Lancet*, 1953, *2*, 639–643.
9. OSWALD, N. C. Chronic bronchitis; factors in pathogenesis and their clinical application. *Lancet*, 1954, *1*, 271–274.
10. REID, L. M. Demonstration at 56th Annual General Meeting of the Association of Physicians of Great Britain and Ireland, 1952.
11. REID, L. M., Pathology of chronic bronchitis. *Lancet*, 1954, *1*, 275–278.
12. REID, L. M. Correlation of certain bronchographic abnormalities seen in chronic bronchitis with pathologic changes. *Thorax*, 1955, *10*, 199–204.
13. SAMMONS, B. P., PISCHNOTTE, W. O., and WILLIAMS, J. R. Bronchographic sign of chronic bronchitis. *Radiology*, 1957, *69*, 389–392.
14. SIMON, G., and GALBRAITH, H. J. B. Radiology of chronic bronchitis. *Lancet*, 1953, *2*, 850–852.
15. SPARKS, J. V., and WOOD, F. G. Radiographic appearances of lungs in chronic bronchitis and in emphysema. *Lancet*, 1932, *2*, 1419–1422.
16. WISOFF, C. P. Bronchiolectasis in chronic bronchitis. *Radiology*, 1958, *70*, 848–850.
17. ZORINI, A. O., and PIGORINI, L. Bronchiectatic bronchiolitis. *Dis. Chest*, 1951, *19*, 658–667.

BRONCHIOLAR ECTASIA: A REPORT OF TWELVE CASES*

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BRONCHIOLAR ectasia or bronchiolectasis has been described only once in the American medical literature when Wisoff[4] reported 2 such cases. Reference to the phenomenon of saccular dilatation of the terminal bronchioles was made by Zorini and Pigorini in 1934 and 1951.[5] Simon and Galbraith[3] in 1953 observed bronchiolar ectasia as a relatively common finding in chronic bronchitis. They called the bronchographic abnormality "peripheral pooling" and noted it in 67 per cent (14 cases) of their patients with chronic bronchitis whose routine roentgenograms suggested emphysema. Only 17 per cent of the remaining 69 bronchograms exhibited this abnormality. Peripheral pooling, however, was only one sign of chronic bronchitis; bronchial diverticula and other abnormalities were also described. Reid[1] in 1954 was able to demonstrate saccular dilatation of bronchioles by histologic examination of specimens obtained from patients with chronic bronchitis. In 1955 Reid[2] correlated the bronchographic abnormalities seen in chronic bronchitis with the pathologic changes and also noted the peripheral pooling. The pools were described as 3 to 5 mm. "blobs" arising from the peripheral bronchial tree.

MATERIAL

A review of 523 bronchograms taken in the past three years at the USAF Hospital, Lackland Air Force Base, Texas, disclosed 12 well defined cases of bronchiolar ectasia. The diagnosis was made solely on the basis of the roentgenographic appearance. A correlation of the clinical findings and symptomatology was then attempted.

All of the cases had symptoms compatible with chronic bronchitis or bronchiectasis except one, which had a persistent pneumonitis in the posterior segment of the right upper lobe. This case was cleared of all possibility of tuberculosis. One case had staphylococcic pneumonia complicated by a pneumatocele six months prior to the first bronchography. Only 2 patients complained of hemoptysis. All but 2 patients smoked between one and two packs of cigarettes a day. In only 2 cases were allergies definitely established. Three patients had bronchiectasis in addition to the bronchiolar changes.

ROENTGENOGRAPHIC APPEARANCE (FIG. 1–10)

Bronchograms of these cases showed the relatively narrow terminal bronchioles with outpouches or pooling of contrast material (aqueous or oily dionosil). The individual dilatation was typically spherical with relatively smooth and well-defined margins. Alveolar filling could be distinguished by its irregular snowflake or lace-like pattern. There was no distinct segmental distribution. In some cases the peripheral pooling was diffuse and widespread, while in others less involvement localized in one or more separate areas was noted. Of particular interest was the case showing multiple ectatic changes of the bronchioles in April, 1958 following a staphylococcus pneumonia, but one year later, repeat bronchography failed to show definite evidence of the process, suggesting that this entity may be a reversible process (Fig. 8 and 9).

SUMMARY

1. Twelve cases of bronchiolar ectasia were found in a review of 523 bronchograms.

2. The entity is diagnosed chiefly by its

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This paper represents the personal viewpoint of the authors and is not to be construed as a statement of official Air Force policy.

FIG. 1. CASE I (B.). Roentgenogram demonstrating multisegmental distribution of bronchiolar ectatic changes. No bronchiectasis is seen.

FIG. 3. CASE III (C.L.). Close-up view demonstrating a single ectatic "pool" arising from the bronchiole.

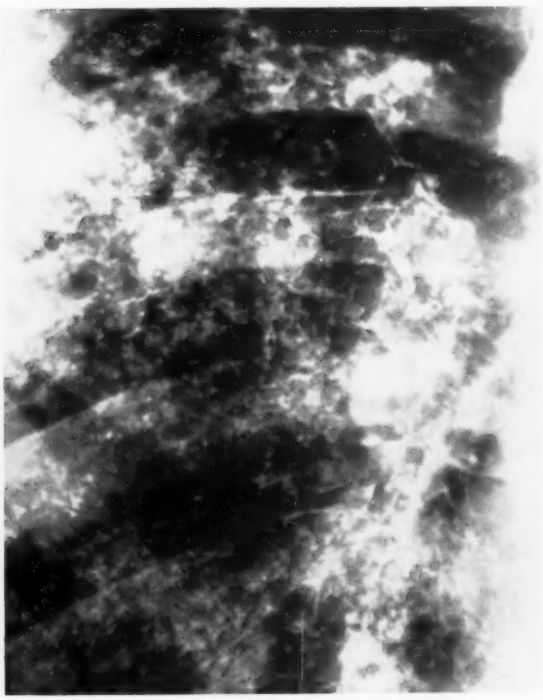

FIG. 2. Example of alveolar flooding (differentiated from bronchiolar ectasia) showing a diffuse, irregular snowflake pattern.

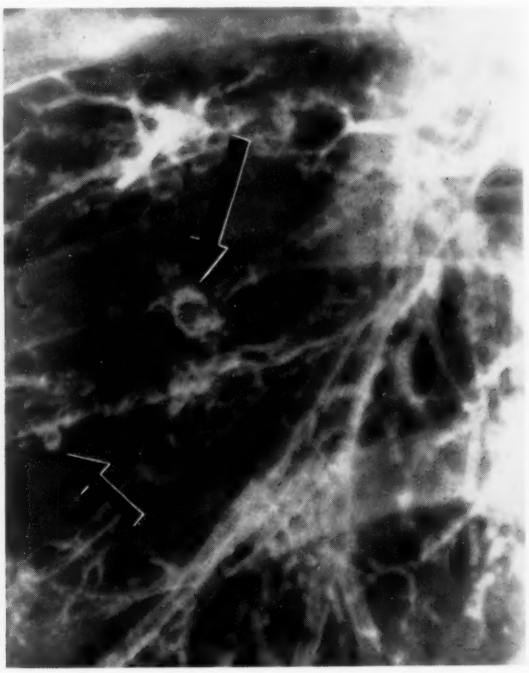

FIG. 4. CASE IV (B.M.B.). Bronchogram showing a few isolated bronchiolar ectatic areas but otherwise normal.

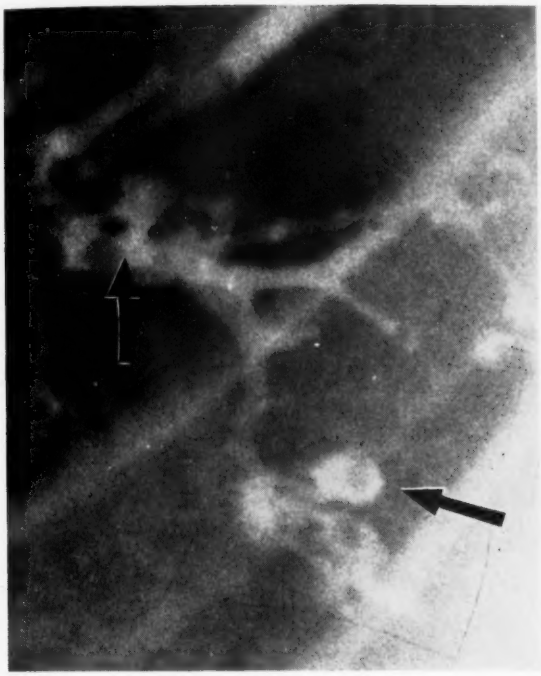

Fig. 5. Case vi (L.P.G.). Close-up view showing several ectatic sites with relative narrowing of the otherwise normal bronchioles.

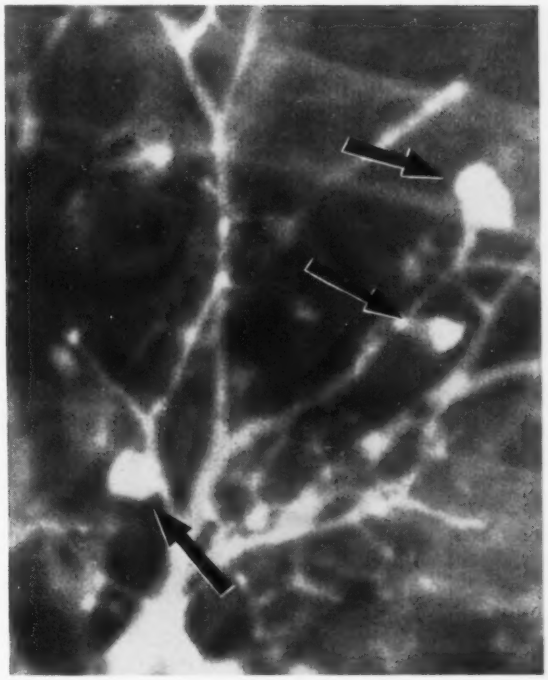

Fig. 7. Case viii (H.N.R.). Close-up view of the left upper lobe. Note the relatively narrowed bronchioles leading to the ectatic "pools."

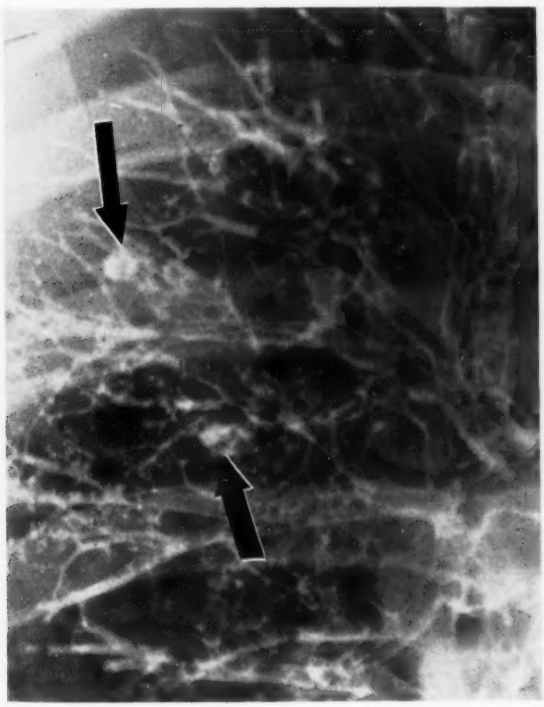

Fig. 6. Case vii (H.S.). Bronchogram of the right upper lobe showing bronchiolar ectasia. The patient also had cylindrical bronchiectasis of several basilar segments.

Fig. 8. Case xi (M.F.K.). Bronchogram of June, 1958 showing diffuse bronchiolar ectasia following an episode of staphylococcic pneumonia.

FIG. 9. Same case as in Figure 8. Bronchogram taken in May, 1959 shows complete clearing of the diffuse ectatic process.

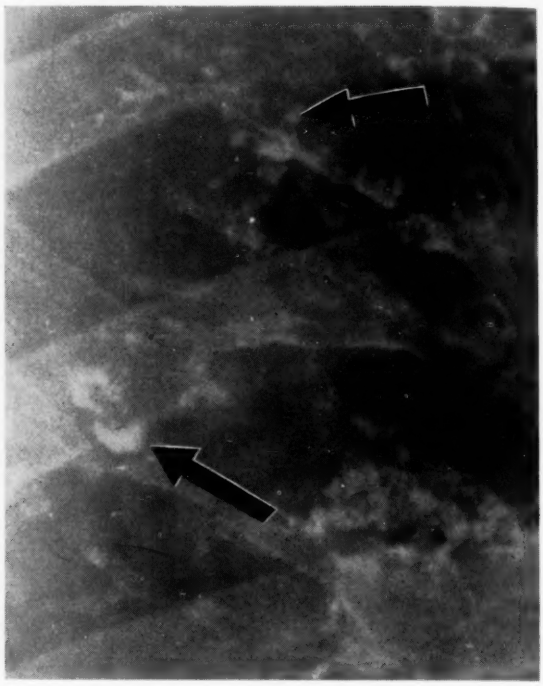

FIG. 10. CASE XII (N.E.C.). Isolated ectatic changes of the bronchioles of varying sizes involving the right upper lobe.

roentgenographic appearance and can be differentiated from alveolar filling.

3. Other investigators noted a relationship between bronchiolar ectasia and chronic bronchitis. In general, this was substantiated by our cases.

4. One patient demonstrated a clearing of the bronchiolar ectatic changes in a year's time, which suggests that the process may be reversible in some cases.

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REFERENCES

1. REID, L. M. Pathology of chronic bronchitis. *Lancet*, 1954, *1*, 275–278.

2. REID, L. M. Correlation of certain bronchographic abnormalities seen in chronic bronchitis with pathological changes. *Thorax*, 1955, *10*, 199–204.

3. SIMON, G., and GALBRAITH, H. J. B. Radiology of chronic bronchitis. *Lancet*, 1953, *2*, 850–852.

4. WISOFF, C. P. Bronchiolectasis in chronic bronchitis. *Radiology*, 1958, *70*, 848–850.

5. ZORINI, A. O., and PIGORINI, L. Bronchiectatic bronchiolitis. *Dis. of Chest*, 1951, *19*, 658–667.

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FLUID COLLECTION IN EMPHYSEMATOUS BULLAE*

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THE development of emphysematous bullae in the course of inflammatory processes in the lungs has deservedly received increasing recognition in the literature. Fluid collection in such newly formed bullae, however, appears to be a relatively infrequent occurrence. Rarer still is the phenomenon of accumulation of fluid in pre-existing emphysematous bullae, secondarily infected from an adjacent pneumonic process. Usually these are erroneously interpreted and treated as lung abscesses. It seems, therefore, worthwhile to describe one case in detail and briefly adumbrate 4 more cases of secondarily infected pre-existing emphysematous bullae with serial roentgenographic documentation. A sixth case is included which represents newly formed bullae developing during current inflammation as a result of adjacent infection.

REPORT OF CASES

CASE 1. W.G., a twenty-six year old Negro male, was admitted to the Mt. Alto Veterans Hospital on May 29, 1956 with the chief complaints of chills, fever and cough of one day's duration. Three weeks prior to admission he noted substernal pain which was aggravated by breathing. The pain gradually subsided. About a week later, he developed a common head cold followed by a cough productive of yellow phlegm. He had just about recovered from his cold and had felt fairly well until the day of admission when he experienced a chilly sensation associated with cough and pain in the pit of the stomach. His past history included frequent head and chest colds and two episodes of spontaneous left sided pneumothorax (1951 and 1952).

Physical examination revealed a tall (6 ft. 4 in.) thin (130 lbs.) acutely ill male with a persistent cough productive of yellow sputum. His temperature was 101.8°F., the pulse rate was 108, respiration 20, and blood pressure normal. The breath sounds were harsh over both lung fields but no rales were heard. Examination of the heart disclosed a sinus tachycardia, a to-and-fro friction rub obscuring the second sound at the aortic area, and a questionable early diastolic rub at the apex.

The pertinent laboratory studies revealed a white blood cell count of 11,500 with a normal differential, a sedimentation rate of 14 mm. per hour and alpha streptococci on sputum smears and culture.

A roentgenogram of the chest on admission showed the same very large emphysematous bullae in the right upper lobe as were seen on a previous roentgenogram of May 12, 1956 (Fig. 1). Three of these bullae had diameters of at least 7–10 cm. in the vertical direction and 3–9 cm. in the horizontal direction. Several smaller

FIG. 1. Case 1. Roentgenogram of the chest taken on May 12, 1956, at the onset of the current illness. Very large bullae are present in the right upper lobe and smaller ones in the right infrahilar region and left apex.

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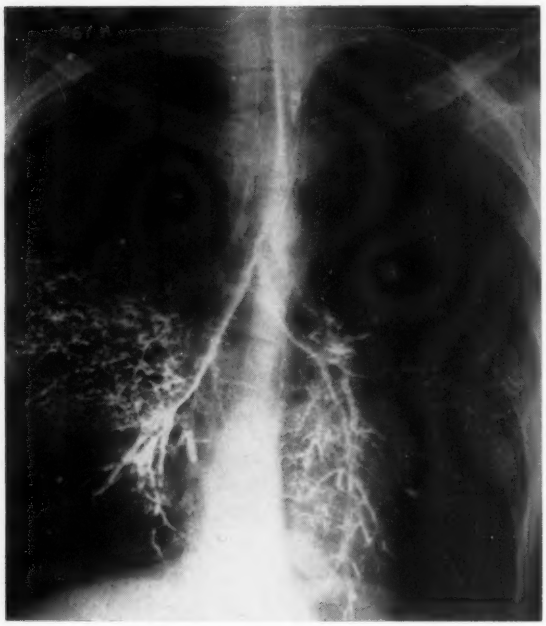

FIG. 2. Case 1. Bronchogram on June 12, 1956. The bronchial branches of the right upper lobe are displaced downward by the large bullae. Clouding and some stippling in the axillary segment of the left infraclavicular region represent the stage of resolution of the pneumonic patch.

bullae were present in the apical segment of the left upper lobe and one in the right infrahilar region. The short fissure was displaced downward. These roentgenograms did not confirm the clinical impression of pneumothorax or mediastinal emphysema.

The patient was empirically treated with penicillin and by the fourth hospital day became afebrile. However, on the eighth day he again experienced chills and a fever of 104°F. That day the roentgenogram of the chest first showed an area of haziness in the axillary segment of the left first anterior interspace consistent with a pneumonic patch. The following day the density extended to the second left interspace. The white blood cell count was reported as 21,200 with 85 per cent polymorphonuclears, 9 per cent of which were stabs. The patient was continued on penicillin therapy and again readily responded. On June 12, 1956, lipiodol bronchography (Fig. 2) revealed some compression, elongation and downward displacement of the bronchial branches of the right upper lobe by the emphysematous bullae. There was no evidence of bronchiectasis.

On the following afternoon the patient once more had a chill and complained of right-sided as well as substernal chest pain. The patient had been using the Bennett machine for positive pressure nebulization. He was found to have a temperature of 104°F. with a respiration rate of 80 and pulse of 104. A roentgenogram on June 14, 1956 (Fig. 3) demonstrated a pneumonic consolidation about 7×4 cm. in the right midaxillary region. It also showed a small collection of fluid in the right suprahilar area in one of the large emphysematous bullae as well as blunting of the right costophrenic sinus. Two days later a chest roentgenogram (Fig. 4*A*) showed a spread of the pneumonic consolidation to involve the entire right upper lobe. The septa of the bullae were thickened and more fluid was seen within the bullae. Roentgenogram on June 22, 1956 (Fig. 4*B*) revealed at least four large air-fluid collections in the bullae. The adjacent pneumonic process already exhibited a considerable degree of resolution. During the next two weeks he ran a febrile course of 102–103°F., which gradually returned to normal. He was started on streptomycin and achromycin, but soon changed to chloromycetin. Because of a drop in hematocrit, attributed to infection, three blood transfusions were given. Two bronchoscopic examinations yielded only a minimal amount of secretion.

FIG. 3. Case 1. Roentgenogram of the chest taken on June 14, 1956. First appearance of a small amount of fluid within one of the larger bullae. Note that there is only a moderate degree of inflammation adjacent to it. Pneumonic consolidation is seen in the right midaxillary region. There is residual lipiodol in both lungs from bronchography.

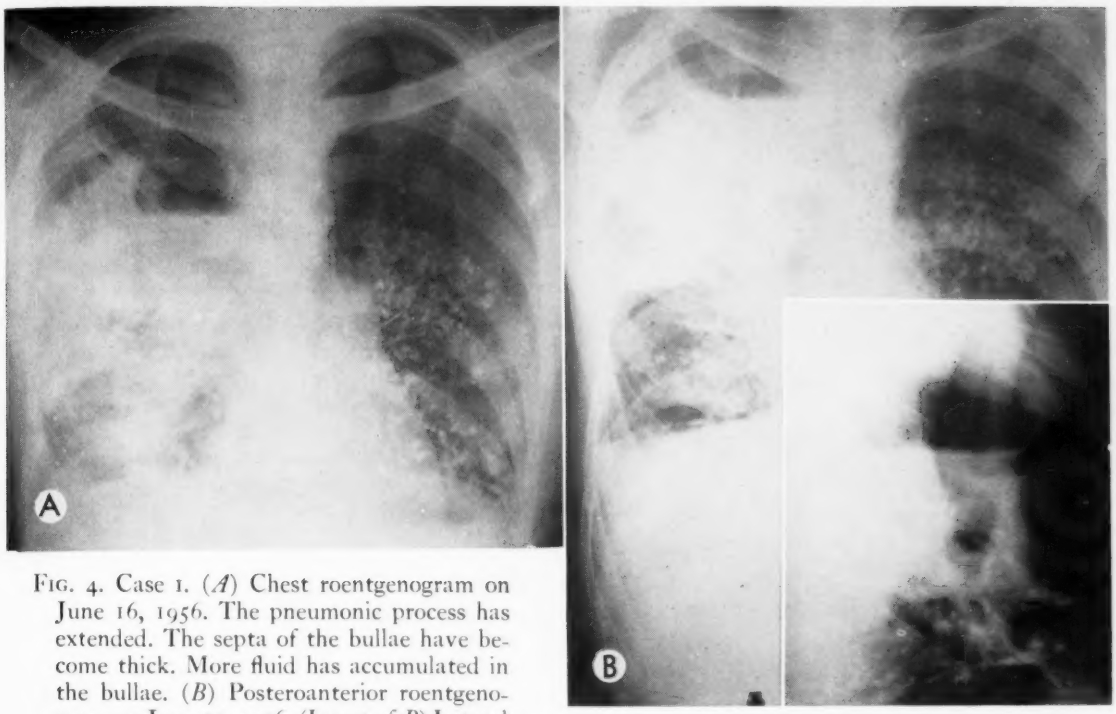

Fig. 4. Case I. (*A*) Chest roentgenogram on June 16, 1956. The pneumonic process has extended. The septa of the bullae have become thick. More fluid has accumulated in the bullae. (*B*) Posteroanterior roentgenogram on June 22, 1956. (Insert of *B*) Lateral view. At least four large air-fluid collections are visible.

On thoracocentesis 80 cc. of thin turbid yellow fluid (not frank pus) was obtained, and this showed no organisms on smear.

From June 28, 1956 onward the patient showed a gradual improvement. By July 9, 1956, the pneumonic process had practically disappeared. A roentgenogram on August 24, 1956 (Fig. 5*A*) no longer showed the fluid collections. Only thickening of the right apical pleura and several linear fibrotic strands remained visible on the roentgenogram of December 4, 1956 (Fig. 5*B*). The emphysematous bullae in the right upper lobe disappeared. The trachea showed retraction to the right, evidently by adhesions. The several smaller bullae in the apex of the left upper lobe remained unchanged.

Case II. Ch. M., a forty year old Negro male, was admitted on March 28, 1958 with the chief complaint of aching pain in his back and adjacent right shoulder region of two weeks' duration. Seven years previously he was hospitalized for bronchopneumonia. At that time, bronchography resulted in a diagnosis of moderate cylindric bronchiectasis involving both lower lobes, the right middle lobe and the lingula of the left upper lobe.

Examination disclosed the patient to be in moderate respiratory distress. He was coughing and bringing up greenish purulent sputum. His temperature was 104.6°F., the white blood cell count was 21,000 with 79 per cent polymorphonuclears, 8 per cent of which were stabs. A roentgenogram of the chest on March 28, 1958 (Fig. 6*A*) revealed a confluent pneumonic consolidation in the posterior segment of the right upper lobe. The right apical and infraclavicular regions were occupied by a large air cavity, one third filled with fluid. Reference to the roentgenogram of December 19, 1950 (Fig. 6*B*) disclosed a pre-existent bulla in this region.

The patient responded readily to antibiotics. The cavity rapidly decreased in size. By April 14, 1958, only a minimal amount of fluid remained at its base. A roentgenogram on August 20, 1958, showed complete resolution of the pneumonic process and disappearance of the air-fluid cavity.

Case III. G.B., a thirty-six year old Negro male with advanced bilateral bullous emphysema and interstitial lung fibrosis, developed fluid in a pre-existing bulla. Figure 7*A* shows the status of his lungs on January 22, 1958. Innumerable curvilinear fine strands are seen

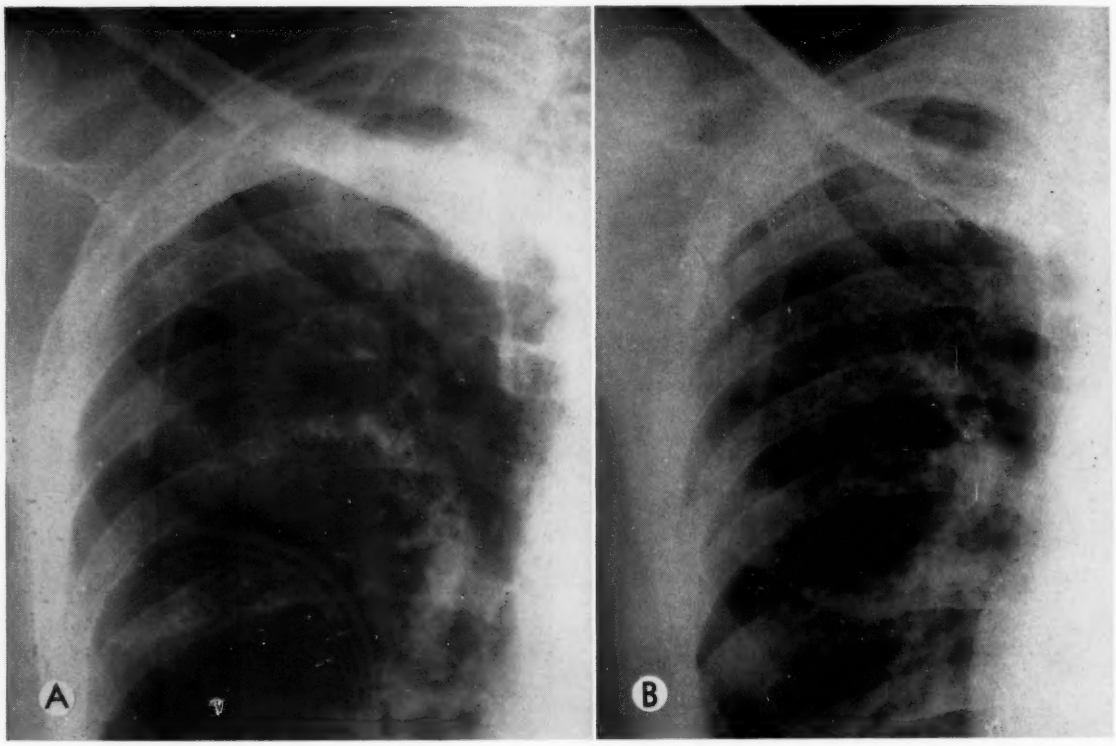

FIG. 5. Case I. (*A*) Chest roentgenogram on August 24, 1956. The pneumonic process has completely cleared. (*B*) Chest roentgenogram on December 4, 1956. The large emphysematous bullae of the right upper lobe have disappeared. Only thickening of the right apical pleura and several fibrotic strands remain to mark the site.

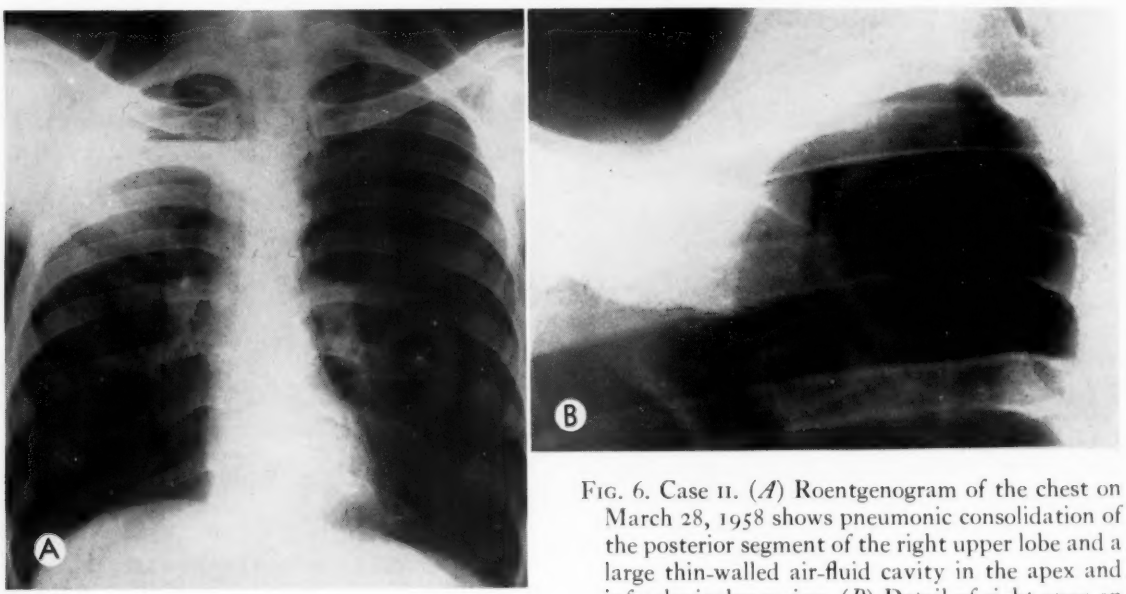

FIG. 6. Case II. (*A*) Roentgenogram of the chest on March 28, 1958 shows pneumonic consolidation of the posterior segment of the right upper lobe and a large thin-walled air-fluid cavity in the apex and infraclavicular region. (*B*) Detail of right apex on December 19, 1950 showing the curvilinear strand delimiting the pre-existent bulla.

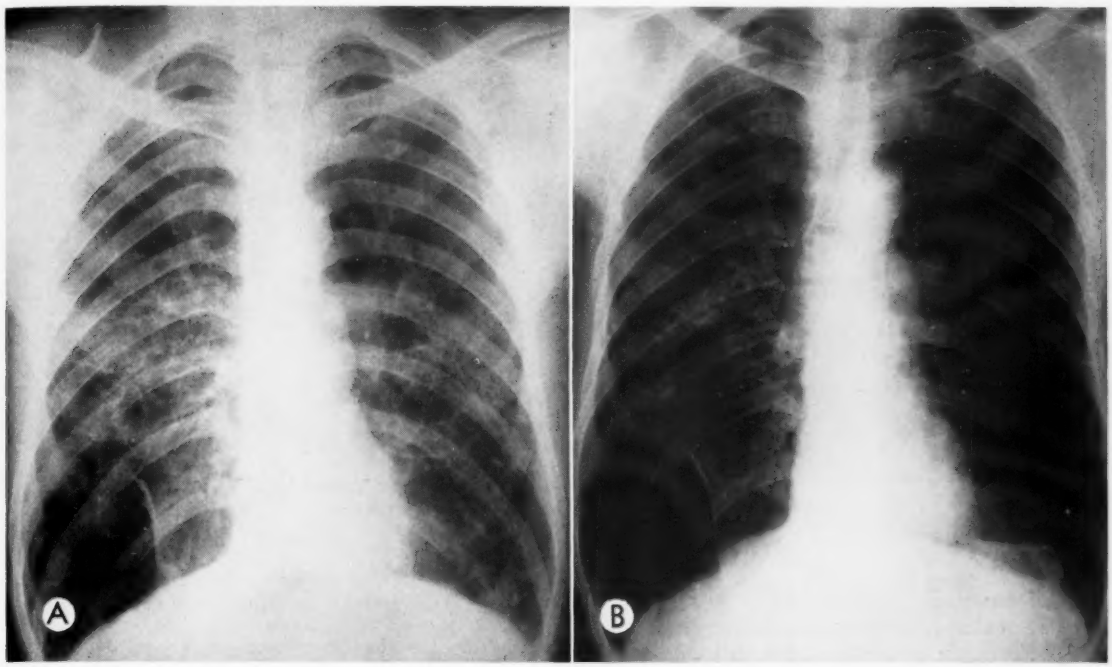

Fig. 7. Case III. (*A*) Posteroanterior roentgenogram of the chest on January 22, 1958 showing typical emphysematous bullae throughout both lungs, more prominent in the middle and lower lung fields. (*B*) Roentgenogram on April 14, 1958 demonstrates the fluid collection in a bulla at the left base.

throughout both lungs, more prominent in the middle and lower fields. The right lower lobe is compressed medially by the very large bullous formation in the lateral half of the base. On April 14, 1958, the patient complained of a "chest cold." A chest roentgenogram (Fig. 7*B*) revealed a collection of fluid (2.5×7 cm.) with a level in a pre-existent bulla at the left base. No significant pneumonic process was detected. He was afebrile and without any signs or symptoms which would suggest a lung abscess. It was decided that the patient did not need any specific medication. A check-up roentgenogram on May 27, 1958 disclosed the complete disappearance of the fluid collection at the left base.

Case IV. F.R., a forty-six year old white male, was admitted on July 19, 1944 with the history of recurrent attacks of mild dyspnea and soreness in the upper chest, sometimes accompanied by cough and expectoration. Two weeks prior to admission the patient experienced a sharp pain in the right chest. A chest roentgenogram done on the outside had been interpreted as showing pneumothorax. However, a chest roentgenogram on July 20, 1944 (Fig. 8*A*) disclosed numerous curvilinear strands in the upper thirds of the lungs, typical of emphysematous bullae. In addition, there were four small fluid collections within the bullae in the right second anterior intercostal space, surrounded by an area of pneumonic consolidation. There was no evidence of pneumothorax. The patient was afebrile, the white blood cell count was 17,500 with 80 per cent polymorphonuclears. He responded readily to symptomatic therapy. A roentgenogram of the chest on October 27, 1950 (Fig. 8*B*) showed extension of the process on the left, so that the bullae occupied more than half of the hemithorax. On the right, the bullae were confined to the apex and first anterior intercostal space.

Case V. L.H., a fifty-five year old Negro male, was admitted on August 20, 1952 because of shortness of breath and chest pain. He was found to have a luetic aneurysm of the aorta and cor pulmonale. Because of an erroneous interpretation of a left-sided pneumothorax, two air aspirations were performed. A review of the admission roentgenogram disclosed advanced emphysema with bilateral bullous formation, especially marked on the left side. A roentgenogram of the chest on September 24, 1952 (Fig.

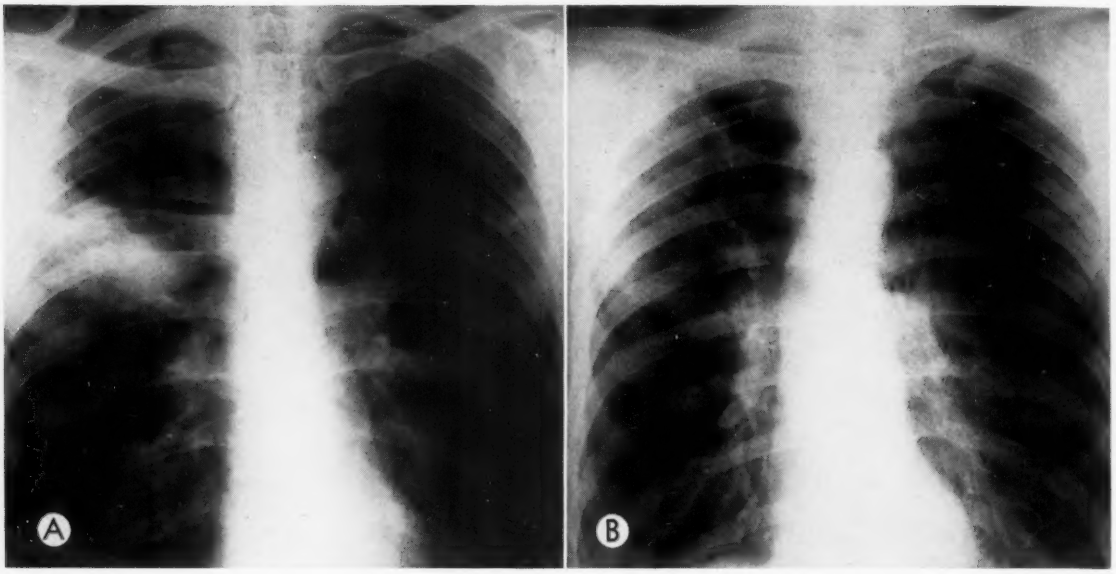

FIG. 8. Case IV. (*A*) Posteroanterior roentgenogram of the chest on July 20, 1944, showing emphysematous bullae in the upper third bilaterally with four fluid levels on the right. (*B*) Roentgenogram on October 27, 1950 shows the extension of the bullae on the left and obliteration of some of the bullae on the right side.

9*A*) showed a small collection of fluid in one of the large bullae at the left base. There were no symptoms or signs suggestive of lung abscess. Soon thereafter two additional fluid levels appeared in adjacent smaller bullae (Fig. 9*B*). All the fluid collections spontaneously disappeared within one month (Fig. 9*C*).

CASE VI. A.M., a fifty-three year old white male, underwent on May 8, 1948, a subtotal gastrectomy for a perforated gastric ulcer of long standing. His postoperative course was stormy. It included: (a) atelectasis of the right middle and lower lobes on the third day, for which bronchoscopy was done and a considerable amount of mucus was aspirated from his bronchial tree; (b) wound dehiscence with evisceration on the seventh day; (c) ligation of the right femoral vein for phlebothrombosis on June 16, 1948; and (d) development of a right-sided empyema. A roentgenogram of the chest on June 7, 1948 (Fig. 10*A*) revealed the sudden appearance of a large emphysematous bulla in the right infraclavicular region. It had a thin wall and measured 4.5 cm. in diameter. There was no evidence of an inflammatory process in its immediate surrounding. The left costophrenic sinus was obscured by a wedge-shaped density suggestive of an infarct. A roentgenogram on June 11, 1948 (Fig. 10*B*) showed pneumonic patches on the superior and medial aspects and a small amount of fluid at the base of the enlarged bulla. On June 28, 1948 another smaller air-fluid cavity appeared superiorly.

By July 14, 1948 (Fig. 10*C*) both cavities had gradually decreased in size. The surrounding inflammatory process had disappeared. The wall of the main cavity was much thinner and only a minimal amount of fluid remained at its base. At no time was there any foul expectoration. Because of the persistent and symptom producing loculated empyema, a thoracotomy was performed on July 15, 1948. Three hundred cubic centimeters of purulent yellow material was removed from the empyema space. At the same time drainage tubes were placed in the empty cavity of the right upper lobe. Histologic examination of a biopsy from its wall showed a zone of granulation tissue with many polymorphonuclear leukocytes, lymphocytes, some plasma cells and an occasional multinucleated giant cell.

The clinical features and the roentgenographic sequence indicate that the inflationary element was the primary and important factor in the pathogenesis of the lung cavity; the inflammation with the abscess formation was secondary.

DISCUSSION

The development of emphysematous bullae in the course of inflammatory processes of the lung was recognized many

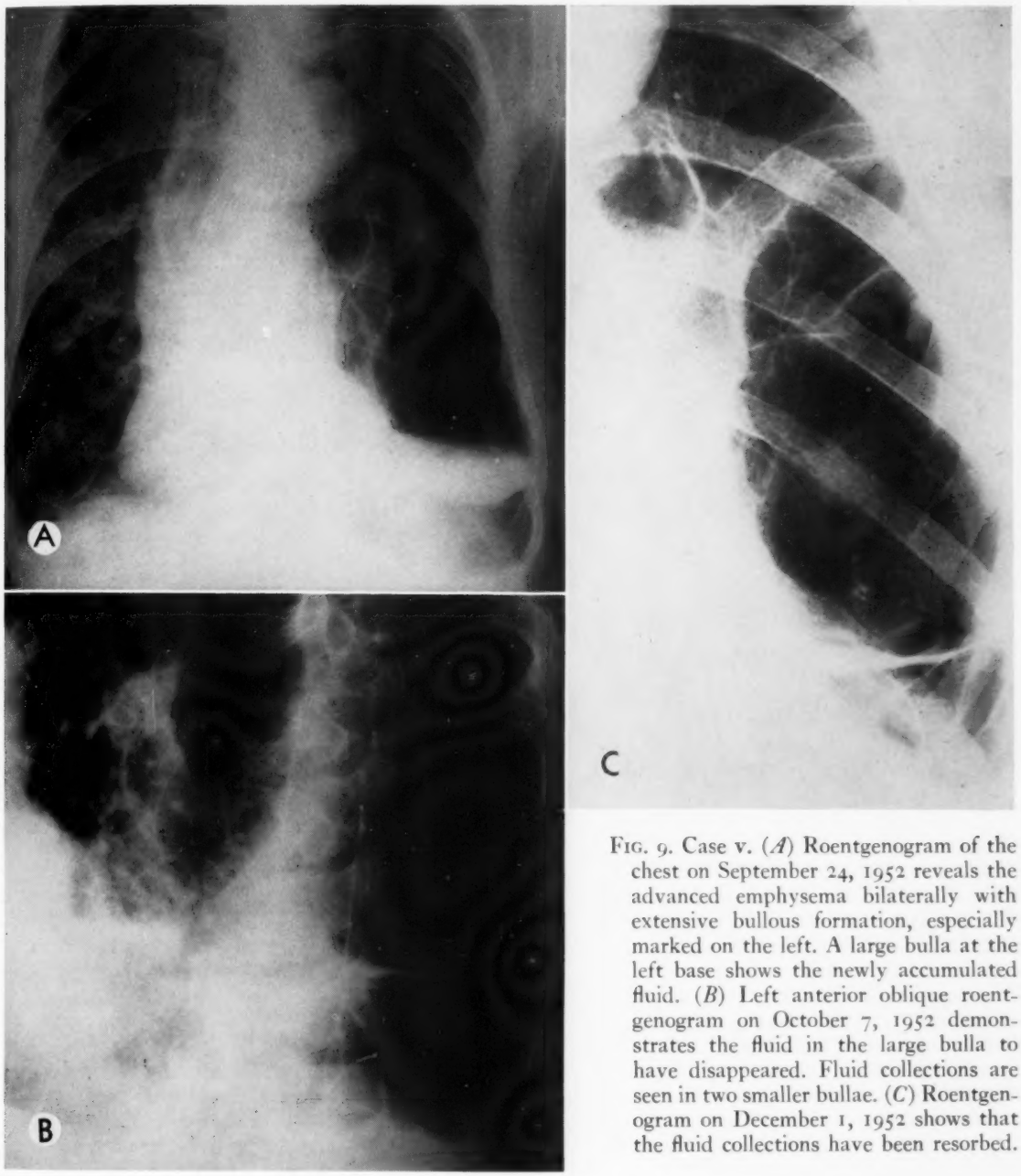

FIG. 9. Case v. (*A*) Roentgenogram of the chest on September 24, 1952 reveals the advanced emphysema bilaterally with extensive bullous formation, especially marked on the left. A large bulla at the left base shows the newly accumulated fluid. (*B*) Left anterior oblique roentgenogram on October 7, 1952 demonstrates the fluid in the large bulla to have disappeared. Fluid collections are seen in two smaller bullae. (*C*) Roentgenogram on December 1, 1952 shows that the fluid collections have been resorbed.

years ago.[8,9,11,12,17,19] In this country it was first emphasized in pediatric roentgenology by Caffey[5] and by Benjamin and Childe.[3] It gained prominence in adults in the mid 1940's in association with the atypical pneumonias. Recently[1] such bullous formation was described in pulmonary tuberculosis and the increasing incidence was attributed to the use of antibiotics. However, as long ago as 1928, Hübschmann[11] illustrated emphysematous bullae in tuberculosis of the lung. With some exceptions,[6,10,13] most authors subscribe to the check-valve mechanism of bronchial obstruction in the genesis of bullae. In an analysis of the possible factors involved in insufflation Alarcon[1] included the following: (a) bronchial stenosis; (b) paren

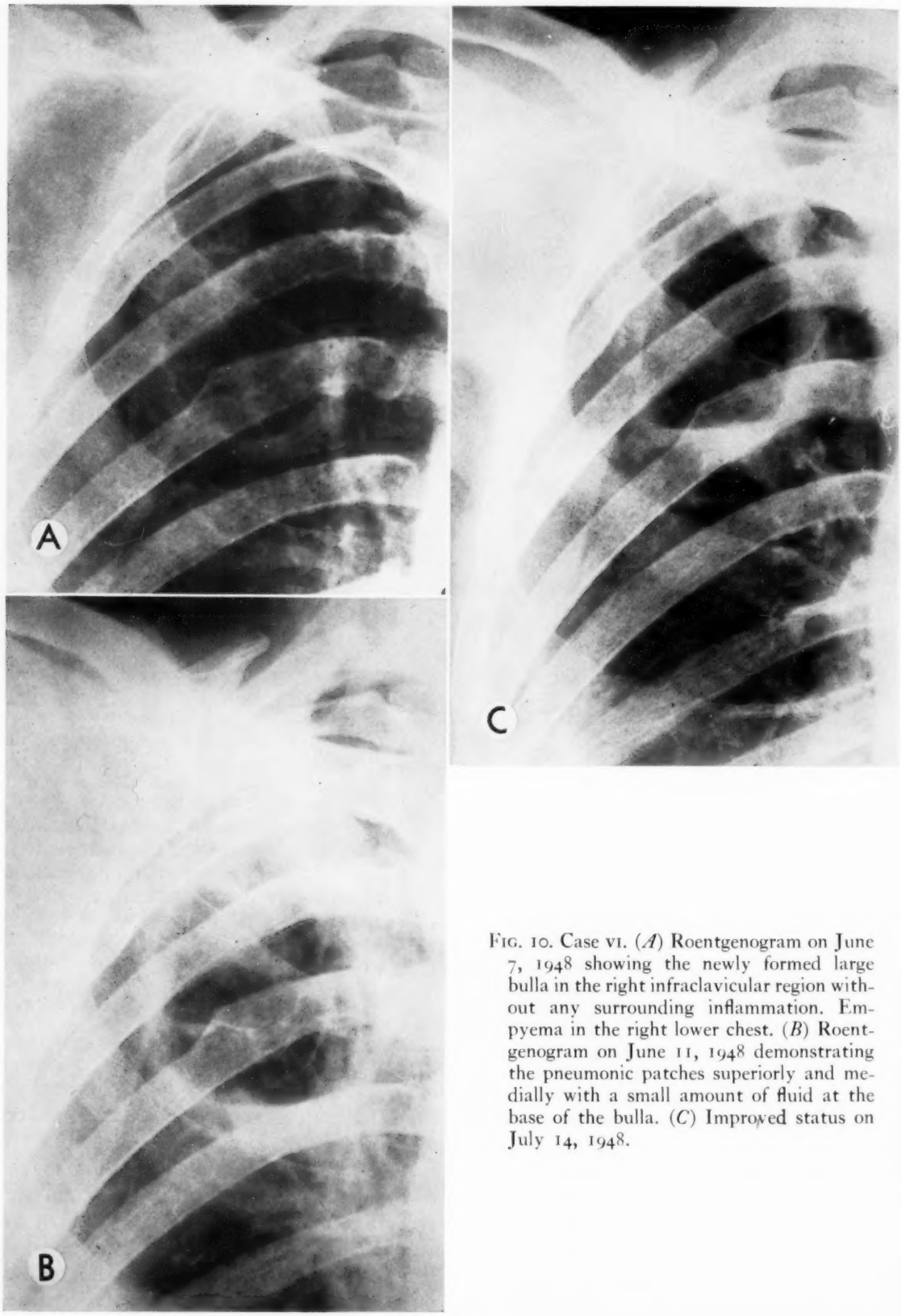

FIG. 10. Case VI. (*A*) Roentgenogram on June 7, 1948 showing the newly formed large bulla in the right infraclavicular region without any surrounding inflammation. Empyema in the right lower chest. (*B*) Roentgenogram on June 11, 1948 demonstrating the pneumonic patches superiorly and medially with a small amount of fluid at the base of the bulla. (*C*) Improved status on July 14, 1948.

chymal destruction of lung; (c) vasculonutrient factor; (d) changes in innervation of the lungs; and (e) mechanical changes, particularly obliteration of the pleural space.

The accumulation of fluid in emphysematous bullae seems to be a relatively rare event. Rothstein[16] in 1954 described 10 cases of infected bullae, 8 of which were in association with pulmonary tuberculosis. He referred to only 3 previous articles and to an illustration in a textbook. It is quite possible that some of the nonputrid abscesses reported in patients with atypical pneumonia might have represented infected bullae. In 1947 Drouet *et al.*[7] presented a patient with infected bullae but encountered difficulty in convincing their discussers, who considered it a case of lung abscesses. Bossi[4] in 1949 reported a case in a sixteen year old asthmatic; a similar case was described by Unger.[18] In 1951 Benda and Franchel[2] presented two cases and listed references to several previous case reports in the French literature.

Some of the above articles deal with bullae, newly formed during the current inflammation and secondarily infected. Case VI represents such an occurrence. The other 5 cases described in this paper are examples of pre-existing emphysematous bullae with subsequent accumulation of fluid in them. All these patients exhibited a favorable course. This is in agreement with the findings of previous authors. The newly formed air-fluid cavity generally disappears spontaneously after the subsidence of the adjacent pneumonic process. Similarly, spontaneous obliteration is encountered in cases of pre-existing small emphysematous bullae which had accumulated fluid as a result of secondary infection. Usually, only some linear fibrotic strands remain to mark the site. However, large preexisting bullae may persist, even though the fluid disappears. Persistence of a large bulla is to be expected, especially when the inflammatory element is slight.

All the articles on this subject stress the importance of differentiating a bulla from a true lung abscess, so as to avoid unnecessary surgical intervention. A marked difference of opinion is found in the literature regarding the criteria for such differential diagnosis. Leopold and Kratzman[15] state that the roentgenographic appearance is typical, though they concede that during the stage when the surrounding lung is consolidated it may be impossible to rule out an abscess. "However, once the pneumonic process is resolved the characteristic roentgen picture makes itself evident and the diagnosis becomes clear." Caffey,[5] at the other extreme, stated that "there is no satisfactory roentgen method for the differentiation of emphysematous from necrotic cavities or for estimating the relative importance of necrotic and inflationary factors when pulmonary cavitation is demonstrated."

While it is true that there is no one absolute criterion for making a definite diagnosis from a single roentgenogram, yet the presence of two or more relative criteria will enable one to diagnose a newly formed and secondarily infected bulla with a high degree of probability. This conclusion is in essential agreement with the view expressed by Lenk[14] in his excellent article. The most important features in favor of a bulla are: (a) rapid appearance and extension of an air cavity, especially when it manifests itself after only a few days of illness; (b) sharp inner margin in the earliest phase; (c) fairly rapid changes of the fluid collection without expectoration of putrid material; (d) relatively slight involvement of the lung immediately surrounding the air cavity; (e) a rather low fluid level—the presence of a high fluid level would speak more in favor of pulmonary suppuration playing a more prominent role than hyperinflation; and (f) a benign clinical course.

In the case of secondary infection and fluid accumulation in previously present bullae, the roentgenographic documentation of their pre-existence at the involved sites establishes the diagnosis. The presence of bullae in other parts of the lungs

should also raise the suspicion that an air-fluid cavity may not be an abscess.

SUMMARY

1. Five cases of secondary infection and fluid accumulation in pre-existing emphysematous bullae are reported. There is also included one illustration of a newly formed bulla which exhibited a fluid collection as a result of adjacent infection.

2. The importance of differentiating these air-fluid collections in bullae from true lung abscesses is stressed. They are characterized by a benign course, though a similar favorable course with disappearance of the air-fluid cavity may nowadays be encountered in abscesses under antibiotic therapy.

3. The roentgenographic features, though not absolute criteria, yet when they occur in combination enable one to diagnose an infected emphysematous bulla with a high degree of probability.

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REFERENCES

1. ALARCON, D. G. Regressive giant bullous emphysema in tuberculosis of adults. *Dis. Chest*, 1955, *27*, 31–43.
2. BENDA, R., and FRANCHEL, F. Sur deux cas d'emphysème bulleux infecté. *Bull. et mém. Soc. méd. hôp., Paris*, 1951, *67*, 1058–1064.
3. BENJAMIN, B., and CHILDE, A. E. Localized bullous emphysema associated with pneumonia in children. *J. Pediat.*, 1939, *15*, 621–639.
4. BOSSI, L. Pseudocisti aerea del polmone di aspetto ascessuale. *Gior. di clin. med.*, 1949, *30*, 568–578.
5. CAFFEY, J. Pediatric X-Ray Diagnosis; A Textbook for Students and Practitioners of Pediatrics, Surgery and Radiology. Third edition. Year Book Publishers, Inc., 1956, p. 269.
6. CHURCHILL, E. D. Architectural basis of pulmonary ventilation. *Ann. Surg.*, 1953, *137*, 1–11.
7. DROUET, P. L., HERBEUVAL, R., FAIVRE, G., and REMY. Emphysème bulleux généralisé avec infection. *J. franç. méd. et chir. thorac.*, 1947, *1*, 428–431.
8. DUKEN, J. Mediastinale Pneumatocele nach Pneumonie bei einem Säugling. *Ztschr. f. Kinderh.*, 1927, *43*, 339–345.
9. ECKSTEIN, A. Ueber Kavernen in den ersten Lebensjahren. *Ztschr. f. Tuberk.*, 1927, *48*, 97–101.
10. HEAD, J. R. Observations of mechanism of emphysema and surgical treatment of dyspnea. *Quart. Bull. Northwestern Univ. M. School*, 1951, *25*, 210–216.
11. HÜBSCHMANN, P. Über Kavernen und Pseudokavernen. *Beitr. z. Klin. d. Tuberk.*, 1928, *67*, 186–191.
12. KLEINSCHMIDT, H. Zur Röntgendiagnostik der intra und extrapulmonalen Hohlenbildung im Kindesalter. *Monatschr. f. Kinderh.*, 1930, *46*, 205–220.
13. LENGGENHAGER, K. Zur Genese des stenotischen Lungenemphysems. *Schweiz. med. Wchnschr.*, 1952, *82*, 542–545.
14. LENK, R. Die Röntgendiagnose der "Pseudoabszesse" der Lunge. *Acta radiol.*, 1947, *28*, 405–413.
15. LEOPOLD, J. S., and KRATZMAN, E. A. Obstructive pulmonary emphysema associated with pneumonia in childhood. *Am. J. Dis. Child.*, 1945, *69*, 287–290.
16. ROTHSTEIN, E. Infected emphysematous bullae; report of five cases. *Am. Rev. Tuberc.*, 1954, *69*, 287–296.
17. ULLRICH, O. Zur röntgenologischen Differentialdiagnose tuberkulöser und nichttuberkulöser Erkrankungen der Brustorgane im Kindesalter. *Fortschr. a. d. Geb. d. Röntgenstrahlen.*, 1927, *36*, 288–298.
18. UNGER, H. Kasuistischer Beitrag zur Differentialdiagnose Lungenabszess—bullöses Lungenemphysem—kavernöse Lungentuberkulose. *Ztschr. f. Tuberk.*, 1950, *94*, 43–45.
19. VOLLMER, H. Cystische Lungengebilde im Kindesalter. *Ztschr. f. Kinderh.*, 1928, *46*, 810–817.

PREOPERATIVE LATERAL LAMINAGRAPHY OF THE CHEST*

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LATERAL laminagraphy is a useful method by which the radiologist can predict the site and extent of lung disease with a considerable degree of accuracy in many instances. We have used this procedure almost routinely prior to surgery in addition to bilateral bronchography and anteroposterior laminagraphy, particularly in cases of tuberculosis. Our surgical staff is thus able to anticipate the findings encountered at surgery, and preoperative planning is thereby simplified.

Lateral laminagrams can also be of much help in the diagnosis of arteriovenous fistulae[2] as well as in cases requiring differentiation between neoplastic and inflammatory diseases. Excellent papers emphasizing the value and accuracy of lateral laminagraphy are available for review.[1,3,4]

INDICATIONS

Lateral laminagraphy has proved to be an important procedure for:

1. *Fissure Demonstration.* Generally, lateral laminagrams are obtained of the desired side with the patient in the recumbent position. Four to 12 cm. levels from the lateral thoracic wall are usually adequate for study. Complete fissures or their increments can be demonstrated in most cases, especially in the more lateral laminagraphic sections, where their margins are anatomically most distinct. If only a portion of a fissure is demonstrated, the remainder can be interpolated, excluding disease which might abruptly cause a change in its course. Accessory fissures can also be seen, particularly the one which separates the superior and subsuperior segments of the lower lobe.

2. *Determination of the Extent of Disease.* This is done by studying the site of the fissures and the relationship of the disease to them. At times, lateral laminagraphy discloses information which may not even be obtained at exploration.

3. *Cavity Demonstration.* In our experience it has been noted that, generally, the lateral laminagram does not demonstrate cavities as well as the anteroposterior laminagram. However, in some instances, a cavity can be visualized in the lateral view which is not seen in other projections, or the lateral laminagram may confirm the presence of a cavity which is only suspected in the anteroposterior view.

4. *Neoplasm Evaluation.* When neoplasm is suspected, the lateral laminagram may demonstrate tracheal or bronchial encroachment, tumor nodule formation, or atelectasis.

5. *Separation of Superimposed Shadows Seen on the Routine Lateral Chest Roentgenogram.* This includes fissure demonstration as described above as well as the separation of other densities ordinarily obscured by the spine.

6. *Visualization of Dilated Bronchi.* Bronchiectatic segments can be demonstrated on occasion as part of an air bronchogram.

7. *Blood Vessel Demonstration and Demonstration of Bone Structures.*

ILLUSTRATIVE CASES

CASE 1. *Neoplasm simulating effusion.* Conventional high kilovoltage posteroanterior and lateral roentgenograms (Fig. 1, *A* and *B*) showed an oval shaped density simulating short fissure interlobar effusion. However, in the lateral view, the density was situated posteriorly. This implied the presence of fluid in an accessory fissure or consolidation in the lower lobe resembling effusion. A lateral laminagram

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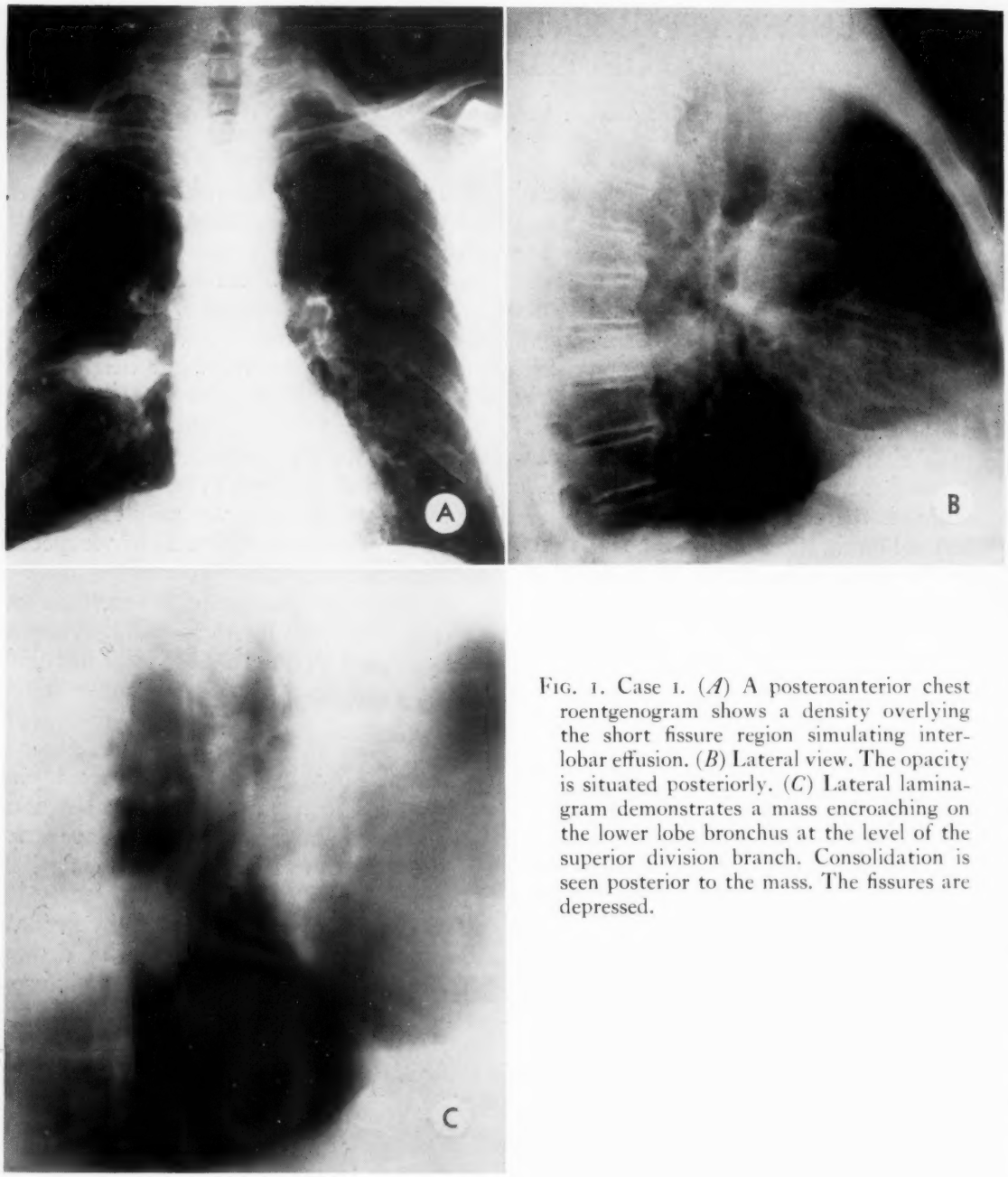

FIG. 1. Case 1. (*A*) A posteroanterior chest roentgenogram shows a density overlying the short fissure region simulating interlobar effusion. (*B*) Lateral view. The opacity is situated posteriorly. (*C*) Lateral laminagram demonstrates a mass encroaching on the lower lobe bronchus at the level of the superior division branch. Consolidation is seen posterior to the mass. The fissures are depressed.

(Fig. 1 *C*) demonstrated a mass encroaching on the lower lobe bronchus at the level of the superior division with lung consolidation posterior to the nodular mass. The fissures were depressed. Bronchoscopy confirmed the roentgenographic findings. Surgery disclosed a carcinoma of the right lower lobe exactly as revealed in the laminagraphic study.

CASE II. *Anatomic extent of disease.* In this case a lateral laminagram (Fig. 2) revealed infiltration and cavitation in the right upper lobe. The superior division of the lower lobe was found to be free of disease.

CASE III. *Anatomic extent of disease.* In this case of tuberculosis, involvement of the apical-posterior division of the left upper lobe and a cavity below the fissure in the lower lobe superior division was demonstrated by a lateral

Fig. 2. Case II. Lateral laminagram reveals a cavity in the posterior division of the right upper lobe in apposition to the long fissure. The superior division of the lower lobe is free of disease.

Fig. 3. Case III. Lateral laminagram shows extensive disease in the apical-posterior division of the left upper lobe. A cavity is also seen definitely situated below the long fissure in the superior division of the lower lobe.

laminagram (Fig. 3). The posterior aspect of the long fissure was slightly displaced superiorly and anteriorly.

Case IV. *Anterior empyema.* In this case a lateral laminagram (Fig. 4) showed a large mass anteriorly and superiorly with the greatest dimension on the pleural surface. The patient had a history of an old therapeutic pneumothorax. The diagnosis of empyema was confirmed at surgery.

Fig. 4. Case IV. A mass density with the widest dimension on the pleural surface is demonstrated on this lateral laminagram, representing localized empyema.

SUMMARY

1. Lateral laminagraphy represents an important roentgenographic method for evaluating with a great degree of accuracy the nature and extent of pulmonary disease.

2. We have used this procedure almost routinely preoperatively, especially for cases of tuberculosis.

3. The lateral laminagram can also be useful in the differentiation of neoplastic and inflammatory lesions from vascular and bone disease.

4. Its frequent use is recommended.

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REFERENCES

1. ADLER, H. Roentgen localization of bronchopulmonary segments by means of laminagraphy, particularly in lung tuberculosis. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1953, *70*, 218–225.
2. AMUNDSEN, P. Planigraphy in Müller and Valsalva experiments. *Acta radiol.*, 1953, *40*, 387–394.
3. ESSER C. Anwendung und Deutung des Schichtbildes bei Lungenprozessen; kritische Überlegungen und praktische Vorschläge. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1953, *78*, 117–141.
4. SIMON, G. Lateral position in chest tomography. *J. Fac. Radiologists*, 1952, *4*, 77–88.

VOL. 83, NO. 2

SELECTIVE BRONCHOGRAPHY

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THE radiologist performing bronchography is confronted with two problems, (1) the choice of a method to fill the bronchial tree, (2) the choice of a contrast medium. Many different methods of filling the bronchial tree have been used.[8] These include injection through a curved cannula in the glottis, an endotracheal tube inserted through the nose or mouth, or puncture of the trachea through the cricothyroid membrane. With all these methods, it is not possible to inject the contrast medium selectively into the bronchi in the area of interest. For this, selective bronchography with Métras' catheters has proved to be a valuable adjunct to the more routine methods. Métras[3] in 1944 introduced several catheters with curved tips for insertion into the various lobes. A semicurved tip catheter was used for injection of the middle or lower lobes. Sharply curved catheters were used for the upper lobes and the superior segment of the lower lobes. Double curved catheters, one for the left and one for the right side, were originally designed for the anterior segments of the upper lobes. In our experience, however, they can be used to enter any segment of any lobe; therefore, these have been employed by us exclusively. These catheters are made of rubber with a radiopaque tip in order that they may be located under fluoroscopic control (Fig. 1).

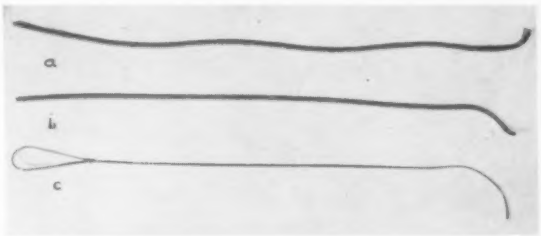

FIG. 1. (*a*) Métras' catheter for bronchography of the left lung. (*b*) Métras' catheter for bronchography of the right lung. (*c*) Wire mandrin for the insertion of the Métras catheters into the trachea. (The Métras catheters are manufactured by the Rüsch Company in West Germany and are available through most United States surgical supply houses.)

OPAQUE MEDIA

The first practical method of bronchography was described in 1922 by Sicard and Forestier[7] who used lipiodol, and iodized oil. This medium provided good contrast with minimal irritation, but it did not mix well with the bronchial secretions. Due to its low viscosity, it tended to pass into the small bronchioles and alveoli from which it could not be expectorated. Consequently, residual lipiodol would often be seen in the lungs for months or years. Lipoid granulomata and fibrosis frequently resulted. To increase viscosity, lipiodol was thickened with sulfonamide powder (visciodol).[2] This permitted easier expectoration and less danger of alveolar filling. It otherwise had the same disadvantages as lipiodol. Aqueous solutions of iodine salts were then introduced.[4,6] These disappeared rapidly but were highly irritating and necessitated considerable anesthesia. Recently, a major step in the search for a better contrast medium was the introduction of dionosil, a microcrystalline suspension of an iodine ester in aqueous or oily medium. This contrast substance is hydrolized by bronchial secretions, absorbed by the bronchial mucosa and secreted in the urine. It disappears from the lungs in four to seven days. The irritative effect of aqueous dionosil is more than that of oily dionosil, but is less than that of aqueous solutions of iodine salts. Recent work has shown that, in spite of the increased irritation of aqueous dionosil, there is no tendency of this medium to form chronic granulomata. Such granulo-

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mata have been shown to result from the use of oily dionosil in animal experiments.[1] Aqueous dionosil mixes better with bronchial secretions and provides a good coating effect. It is possible to alter the viscosity of this medium by pouring out the watery supernatant fluid after the contrast material has settled toward the bottom. This gives a material of higher viscosity for use when the interest is in the more proximal branches of the bronchial tree. For the demonstration of peripheral bronchi and for use in children, the medium is used as provided by the manufacturer. For these reasons, aqueous dionosil has been selected as the medium of choice.[9]

TECHNIQUE

Adequate anesthesia of the posterior pharynx, epiglottis, and glottis is essential for introduction of the Métras catheters. For surface anesthesia one-half per cent xylocaine solution is used. To minimize the possibility of a sensitivity reaction, it is best to secure this anesthesia with 10 cc. or less. For premedication, 100 mg. nembutal, 30 mg. codeine, and 0.4 mg. atropine are given. Topical anesthesia is begun by spraying the tongue and mouth with the nozzle directed posteriorly against the wall of the pharynx. After this area has been adequately anesthetized, the nozzle is directed inferiorly and the area comprising the hypopharynx, epiglottis and glottis is sprayed. During this time the patient is instructed to breath through his mouth. Under laryngoscopic control, 1 cc. of anesthetic solution is dropped into the trachea through a curved cannula. A wire mandrin is slipped through the Métras catheter until it reaches the tip, but does not protrude. Under laryngoscopic control

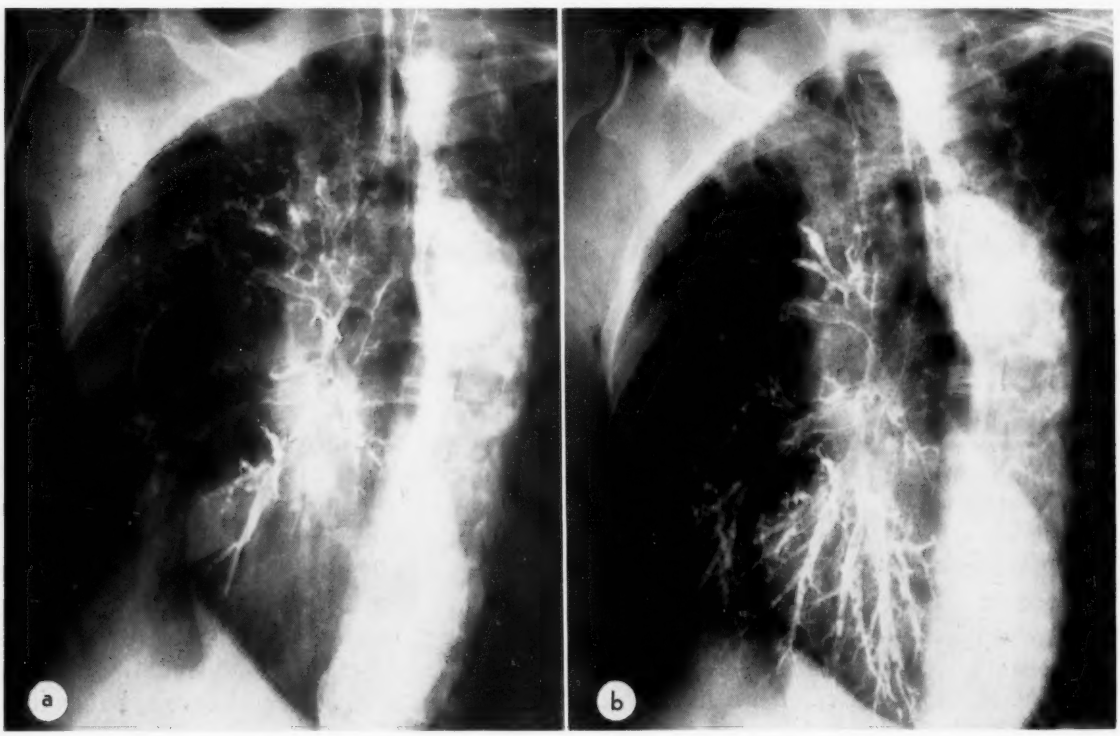


FIG. 2. (*a*) Routine bronchogram of the right lung of a sixty year old patient showing bronchiectasis in the right upper lobe. The bronchi of the right middle lobe and lower lobe are incompletely filled. (*b*) Selective bronchogram of the right lower and middle lobes demonstrates some crowding of the bronchi due to pleural thickening in the costophrenic angle and in the lower part of the long lung fissure. No bronchiectatic changes are present in the middle lobe and lower lobe.

again, the catheter, with the guide wire inside, is placed over the center of the base of the tongue. It is passed posteriorly to the epiglottis until the tip is just above the vocal cords. The patient is then asked to take a deep breath and, during this, the catheter is advanced over the guide wire into the trachea. When the catheter is well within the trachea, the guide wire is removed, while the catheter is held in place. The patient is asked to hold the catheter in his mouth as he would a cigarette. He may then be positioned on the fluoroscopic table in the posterior oblique position on the side to be studied.

Under direct fluoroscopic control, the tip of the Métras catheter is placed into the orifice of each of the major bronchi on the side to be examined and 1 cc. of the xylocaine solution is injected. The catheter is then replaced into the upper lobe bronchus or into one of its segmental bronchi. After the patient is turned into a slightly head down position, the contrast medium is injected. The degree of filling is controlled by the fluoroscopic findings. Spot roentgenograms are made whenever adequate filling of the lobe or segment is seen. Ideal filling is when peripheral bronchi are demonstrated without evidence of alveolar filling. Care should be taken to insure that the contrast medium is not passing into the other lung. The upper lobe is usually filled first, followed by the middle lobe or lingula. For injection into the lower lobe, the patient is tilted to a semi-erect position.

With the selective method, it is possible to fill the entire bronchial tree of one lung. After such filling excellent roentgenograms may be obtained with the overhead tube. Anteroposterior, oblique and lateral roentgenograms are taken in recumbent and sometimes upright positions. For visualizing cysts, bronchiectatic sacs, or some bronchial filling defects, it may be desirable to have the patient cough after the bron-

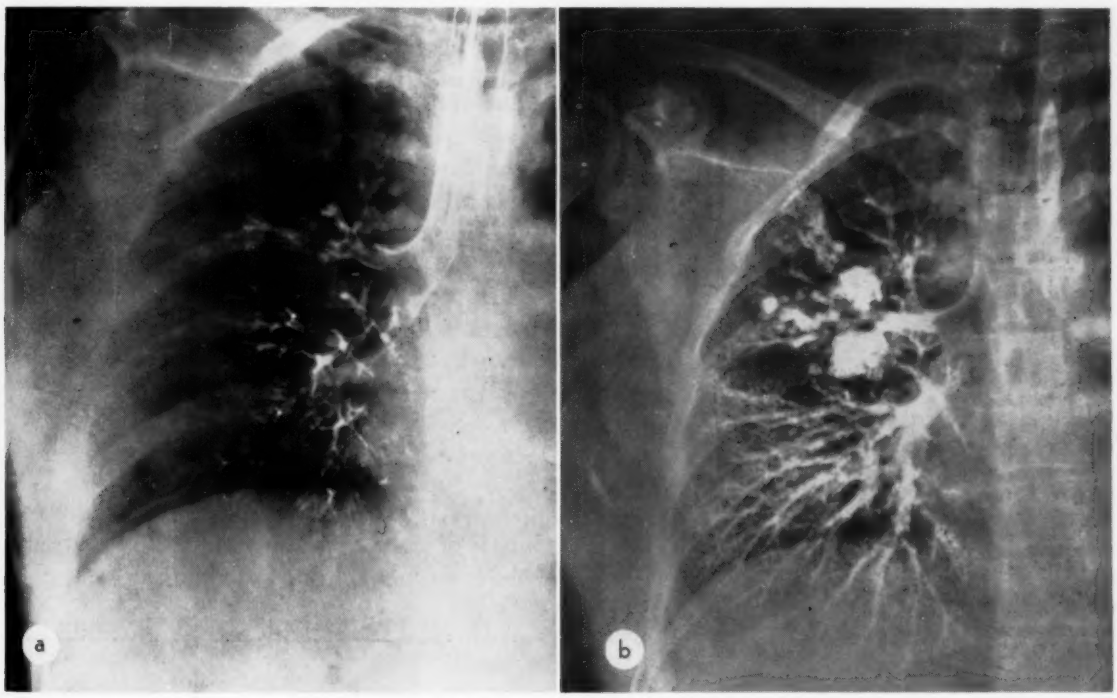


Fig. 3. (*a*) Routine bronchogram of a fifteen year old patient shows an incomplete filling of the bronchi of the right upper lobe. No pathologic changes are demonstrated. (*b*) By selective bronchography it was possible to fill alveolar cysts in the posterior segment of the right upper lobe. This examination together with other laboratory findings suggests the diagnosis of congenital fibrocystic disease.

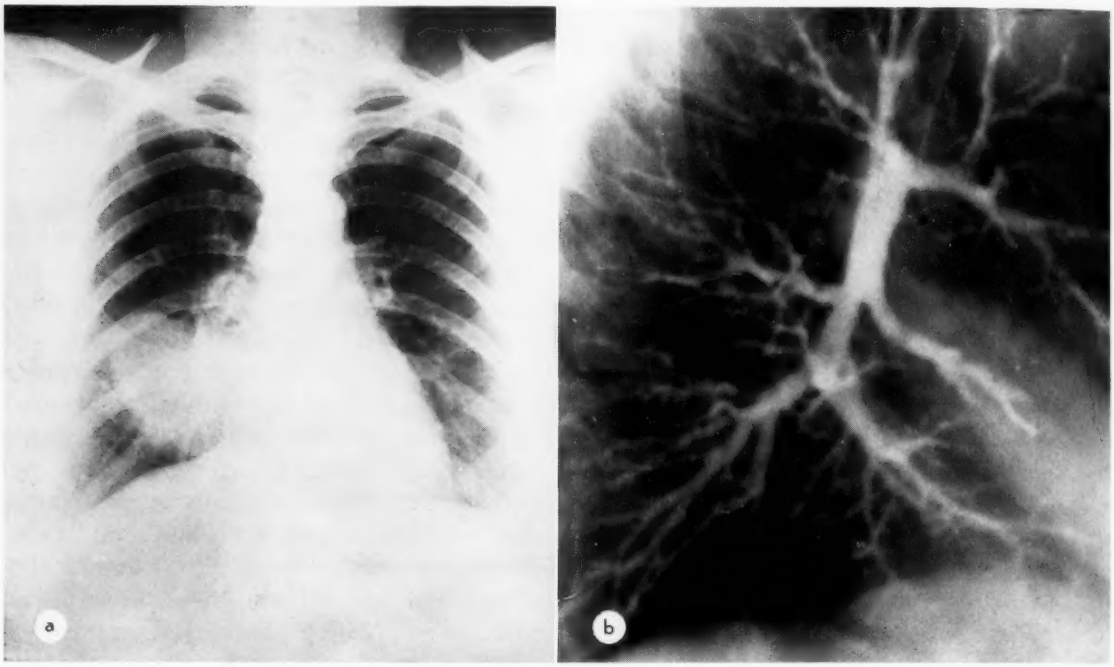
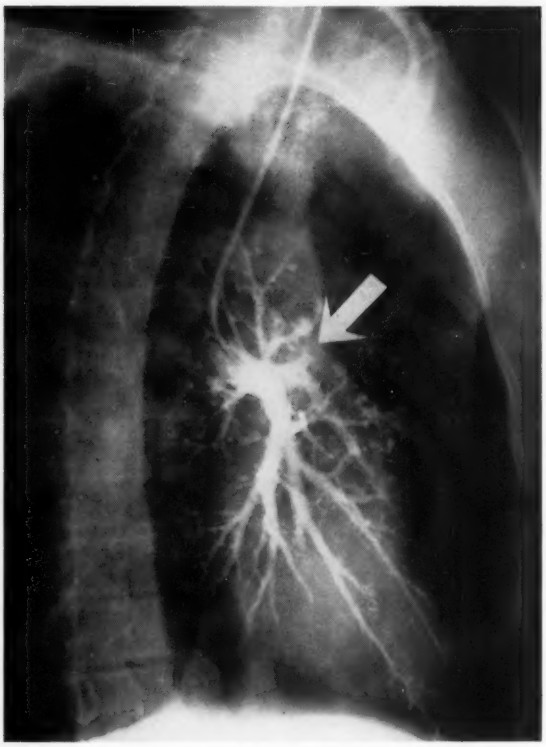


FIG. 4. (*a*) The chest roentgenogram of a thirty-nine year old patient demonstrates a radiopaque area in the right lower lung field suggesting the presence of right middle lobe atelectasis. (*b*) No obstruction of the middle lobe bronchus is demonstrated on the selective bronchogram. The partial atelectasis of the right middle lobe is due to chronic pneumonia.



chial tree is filled. This causes the contrast medium to flow further peripherally and provides relief for air contrast visualization of the bronchial outlines. To diminish the fluoroscopic dose of radiation to patient and radiologist, image intensification is desirable. This also permits taking motion pictures of the filling process, which we have done in our institution for teaching and research purposes.

DISCUSSION

Selective bronchography offers the possibility of instilling contrast media into any lobar, segmental or subsegmental bronchus

FIG. 5. The selective bronchogram of the left lung of a fifty-six year old patient shows nonfilling of the bronchi of the left upper lobe with the site of obstruction well demonstrated (arrow). Diagnosis: bronchogenic carcinoma.

under fluoroscopic control. Routine bronchography, in which the contrast medium is directed by positioning of the patient or by inspiratory effort, often fails to adequately demonstrate the entire bronchial tree. Failure of filling in a diseased area may be due to retained secretions, narrowing of the lumen, or lack of aeration secondary to atelectasis or infiltration. In approximately 50 per cent of cases, the routine method, which allows visualization of the bronchial trees of both lungs in one procedure, will give satisfactory information. Therefore, it should be used as the initial procedure. If there is failure to visualize a particular area of interest, selective bronchography of the previously incompletely filled area is the method of choice. Since selective bronchography requires separate catheters for each side, only one lung may be examined at a time. This procedure can be used initially for definitive anatomic localization and where a well-defined diseased segment or lobe is to be investigated. Some examples of selective bronchograms which illustrate the value of this method are presented in Figures 2, 3, 4, and 5.

CONCLUSION

The indications for selective bronchography are: (1) the failure to fill an interesting area by more routine methods, (2) the anticipation of such failure in an area of disease localized to one side, (3) definitive localization of pathology for surgery.

SUMMARY

The procedure of selective bronchography using Métras' catheters is described and its indications are discussed.

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REFERENCES

1. Björk, L., and Lodin, H. Pulmonary changes following bronchography with dionosil oily (animal experiments). *Acta radiol.*, 1957, *47*, 177–180.
2. Dormer, B. A., Friedlander, J., and Wiles, F. J. Bronchography in pulmonary tuberculosis. *Am. Rev. Tuberc.*, 1945, *51*, 62–69.
3. Métras, H. Le cathétérisme des bronches lobaires avec une sonde en caoutchouc. *Presse méd.*, 1944, *52*, 181–182.
4. Niknejad, I., Aurelius, J. R., Peterson, D. H., and Rigler, L. G. Current status of bronchography with water-soluble media; report of 74 examinations with "umbradil viscous B." Am. J. Roentgenol., Rad. Therapy & Nuclear Med., 1956, *75*, 701–719.
5. Nordenström, B. E. W., and Norlin, U. A. T. Bronchography with Métras' catheters. *Acta radiol.*, 1951, *35*, 246–249.
6. Schinz, H. R., Baensch, W. E., Friedl, F., and Uehlinger, E. Roentgen-Diagnostics. Vol. III. English translation arranged and edited by J. T. Case. Grune & Stratton, Inc., New York, 1954.
7. Sicard, J. A., and Forestier, J. Méthode générale d'exploration radiologique par l'huile iodée. *Bull. et mêm. Soc. méd. d. hôp de Paris*, 1922, *46*, 463–469.
8. Vickers, A. A. Bronchography, methods by which it may be performed and factors influencing choice of methods employed. Part I. *Brit. J. Radiol.*, 1949, *22*, 137–151; also Part II, 1949, *22*, 224–233.
9. Willson, J. K. V., Perilla, F. R., and Hanchett, R. B. Bronchography with dionosil (propyliodine); new absorbable bronchographic medium. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., 1956, *75*, 720–727.

DILATATION OF THE AORTIC SINUSES IN THE MARFAN SYNDROME: ROENTGEN FINDINGS IN FIVE NEW CASES*

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ANGIOCARDIOGRAPHY has made possible the diagnosis of aneurysmal dilatation of the aortic sinuses (of Valsalva) in Marfan's syndrome during life.[32] Marfan's syndrome has become recognized as a heritable disease of connective tissue in which cystic medial degeneration of the great vessels, especially the aorta, occurs frequently.[22,24,31,32,42] As a result aneurysms of the ascending aorta with rupture and dissection are common.[1,2,4,8,10,16–19,22,24,25,27,28,31,40–44,46] Tung and Liebow[42] have also pointed out that the aortic sinuses are favorite sites of medial cystic degeneration in Marfan's syndrome and this has been confirmed by the angiocardiographic demonstration of dilatation of the aortic sinuses in the cases herein reported.

Ten patients with dilatation of the aortic sinuses in Marfan's syndrome have been studied at this center (Table 1). Three cases were initially reported in 1955.[32] Identical twins, aged two years, have also recently been reported.[37] These patients and 5 new cases form the basis of this report and will serve to illustrate the clinical and roentgen features of aortic sinus (of Valsalva) involvement in Marfan's syndrome.

REPORT OF CASES

CASE I. A twenty-three year old woman (N.Y.H. No. 724086) was referred for angiocardiography by Dr. John M. McLean on March 12, 1956. Bilateral dislocated lenses had been present since birth and a previous operation for correction of the deformity had been unsuccessful. Left intracapsular lens extraction and iridotomy were done and during the recuperative period cardiovascular studies were made.

The patient was thin (weight, 110 pounds) and tall (5 feet, 10 inches) with long, dangling, limbs and fingers (Fig. 1*A*). There was a funnel type of deformity of the lower sternum. The palate was arched and the skull was dolichocephalic. The heart was not enlarged. A rough systolic (grade 2) murmur was present at the apex. The aortic and pulmonic second sounds were equal and there were no murmurs at the base of the heart. The blood pressure was 120/80 mm. Hg. The conventional roentgenogram of the heart showed slight scoliosis of the spine to the right. The heart was normal in size but the pulmonary artery appeared to be prominent (Fig. 1*B*). The lower part of the sternum was moderately concave (Fig. 1*C*). Angiocardiography disclosed slight indentation of the inner distal portion of the superior vena cava, the superior right atrial and the inner pulmonary conus borders by a widened aortic root (Fig. 1*D*), which later in the series was shown to be due to dilatation of the aortic sinuses (Fig. 1, *E* and *F*). The left ventricle was normal.

CASE II. A twenty-two year old man (N.Y.H. No. 736343) was referred to the clinic because of a heart murmur. This was first heard following measles and whooping cough at the age of two years. Physical activities were then restricted and he remained well until he began having "growing pains" at the age of fourteen years. Nose bleeds and sinusitis followed but had subsided during the previous two years. The patient denied disability and stated that dyspnea occurred only after running twenty yards and after climbing two flights of stairs.

The patient was tall (6 feet, 6 inches) and weighed 163 pounds. The lower thorax was depressed and funnel shaped. A loud, harsh, systolic (grade 3) murmur was heard over the apex of the heart and radiated over the entire precordium and into the left axilla and back. A low pitched diastolic murmur at the mitral area was also heard. The pulmonic sound was louder than the aortic. The blood pressure

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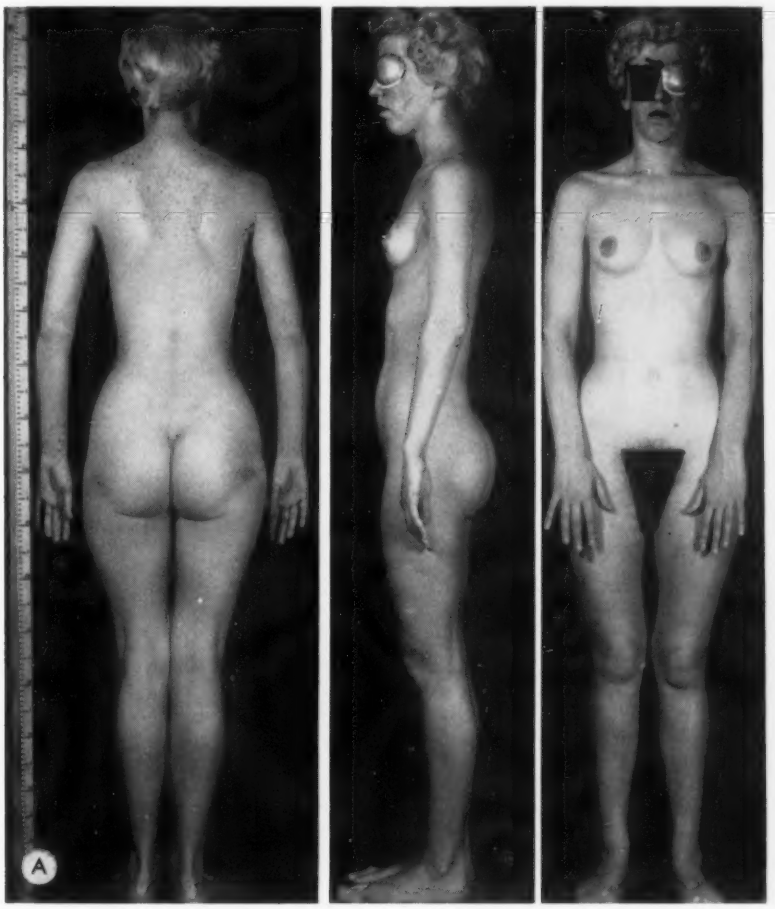

Fig. 1. Case 1. (*A*) Photographs of a twenty-three year old woman with the characteristic long and thin habitus of Marfan's syndrome. Note the unusually long fingers and toes. Eye patch over left eye followed recent intracapsular lens extraction and iridotomy.

was 126/75 mm. Hg. Electrocardiographic study showed normal sinus rhythm, rate 88 per minute, with deviation of the electrical axis to the left. Roentgen study of the chest on April 16, 1956, revealed a slight pectus excavatum deformity with narrowing of the anteroposterior diameter of the thorax. The left ventricle was moderately enlarged (Fig. 2, *A* and *B*). Angiocardiography demonstrated moderate dilatation of the aortic sinuses and left ventricular hypertrophy (Fig. 2*C*).

Case III. A twenty-four year old man (N.Y.H. No. 771036) was referred by Dr. Milton L. Kramer. A heart murmur was first heard during a routine physical examination in high school and later the murmur caused him to be rejected for work. Neurofibromatosis (von Recklinghausen's disease) was diagnosed after biopsy of a skin tumor six years prior to admission to this hospital. The patient was tall (5 feet, 10½ inches) and thin (117 pounds) and had multiple *cafe au lait* nodules over the body varying in size from pinpoint to 7 cm. diameter. There was concavity of the lower sternum. The heart was not enlarged on physical examination. A systolic (grade 2 to 3) murmur was heard in the third left interspace near the sternum. The pulmonic sound was louder than the aortic, and was accentuated and split. The blood pressure was 116/80 mm. Hg. The electrocardiogram was normal.

Roentgen study of the chest (Fig. 3*A*) showed slight prominence of the left cardiac silhouette and there was also a slight concavity of the lower sternum (Fig. 3*B*). Cardiac catheterization on July 24, 1956 disclosed normal hemodynamics and, therefore, angiocardiogra-

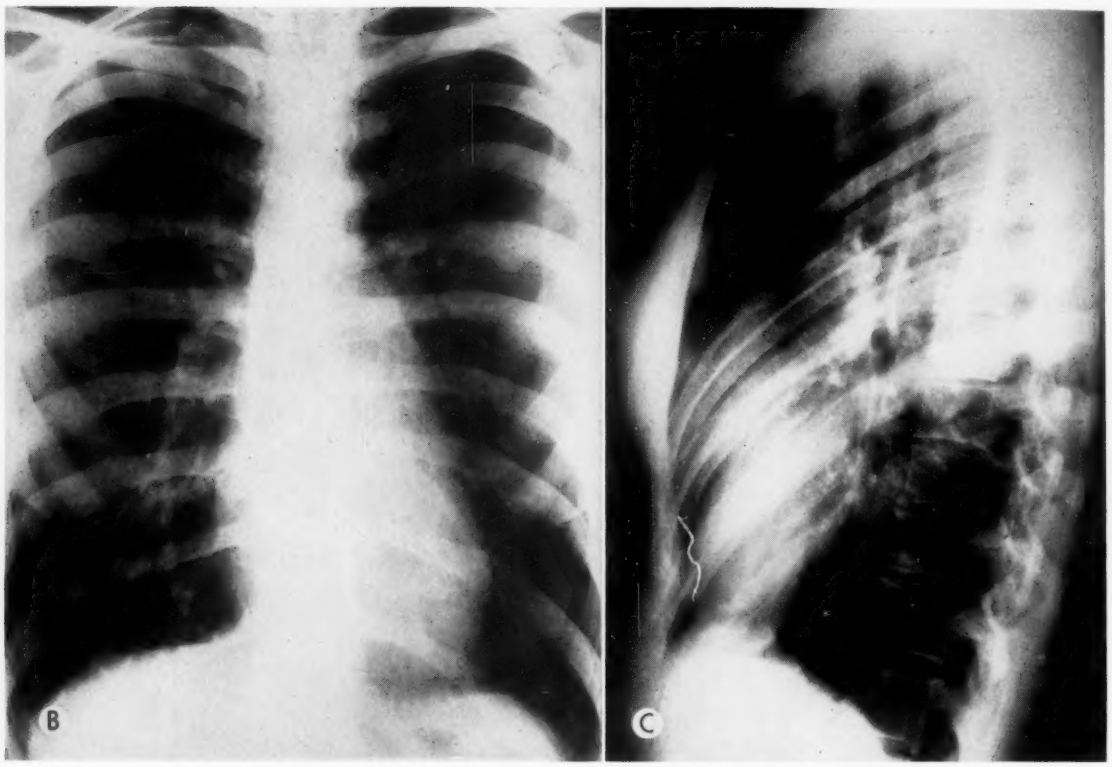

FIG. 1. Case I. (*B*) Frontal teleroentgenogram shows the unusually long thoracic cavity. The heart is normal in size and contour. (*C*) Lateral teleroentgenogram also shows the long thoracic cage. There is slight funnel-shaped deformity of the lower sternum; the heart appears normal in size.

phy was advised. This revealed the characteristic deformity of the right heart structures by moderately dilated aortic sinuses (Fig. 3*C*); the left ventricular cavity was somewhat enlarged (Fig. 3*D*).

CASE IV. A thirty-nine year old mortician was admitted on December 4, 1957 (N.Y.H. No. 783583) with a complaint of severe dyspnea of eleven months' duration. The patient was well and unaware of heart trouble until four years prior to entry when enlargement of the heart was found during a life insurance examination. Despite this, a year later, following a pre-employment physical examination, he was accepted for work. Dyspnea after heavy exertion began two and a half years prior to admission. Two years ago, prior to repair of inguinal hernias, heart trouble was diagnosed and resulted in the choice of spinal rather than general anesthesia. Gradually, dyspnea increased until eleven months prior to admission he became totally disabled with frequent colds, bouts of fever and cough. Subsequently, he developed ankle edema and required restriction of salt intake, digitalis and mercurial diuretics. The patient's three children (including a set of twins) have also been examined and found to have the stigmata of Marfan's syndrome (skeletal deformities and dislocated lenses of the eyes).

The patient was tall (6 feet, 2 inches) and slender (weight, 187 pounds); the palate was arched. The chest was not deformed and the extremities, fingers and toes were not abnormally long. The heart was very active and a systolic thrill was felt over the base of the heart extending into the neck. The heart was markedly enlarged, reaching beyond the mid-axilla in the left fifth costal interspace. The rhythm was regular sinus, rate 85 per minute. Over the aortic area, a harsh, medium pitched, systolic murmur was transmitted into the neck, and a high pitched diastolic murmur extended from the aortic area to the left sternal border. A mid-diastolic murmur was heard at the apex of the heart. The pulses were bounding (Corrigan type) and the blood pressure was 150/45 mm. Hg. The liver was enlarged two finger breadths below the right costal margin. Bilateral indi-

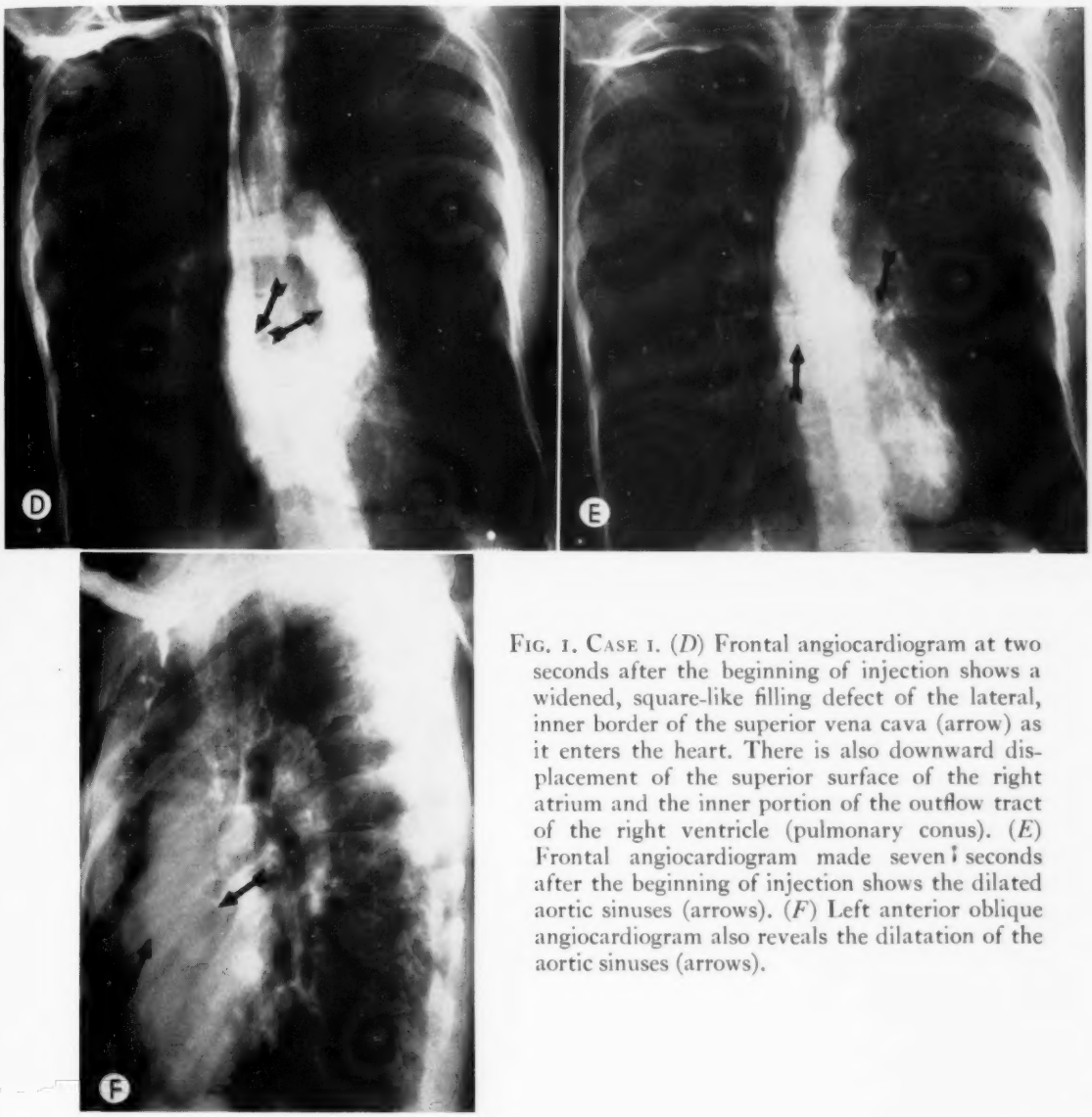

Fig. 1. Case 1. (*D*) Frontal angiocardiogram at two seconds after the beginning of injection shows a widened, square-like filling defect of the lateral, inner border of the superior vena cava (arrow) as it enters the heart. There is also downward displacement of the superior surface of the right atrium and the inner portion of the outflow tract of the right ventricle (pulmonary conus). (*E*) Frontal angiocardiogram made seven seconds after the beginning of injection shows the dilated aortic sinuses (arrows). (*F*) Left anterior oblique angiocardiogram also reveals the dilatation of the aortic sinuses (arrows).

rect reducible hernias were present. Ophthalmologic examination disclosed myopia. The electrocardiogram showed deviation of the electrical axis to the left and marked left ventricular hypertrophy.

Roentgen study of the chest revealed marked left ventricular enlargement with striking dilatation of the ascending aorta (Fig. 4, *A* and *B*). Angiocardiography was done on December 10, 1957, and showed a dilated superior vena cava and a huge filling defect of the upper part of the right cardiovascular structures (Fig. 4*C*), caused by aneurysmal dilatation of the ascending aorta and aortic sinuses (Fig. 4*D*). There was also enlargement of the right ventricle, pulmonary artery and left atrium. The left ventricular cavity and wall were markedly enlarged.

On June 6, 1958, the patient developed strangulation of the intestines in the right hernial sac that required immediate operation for relief. After an uneventful recovery, on January 24, 1958, a Hufnagel valve was inserted into the descending aorta beyond the left subclavian artery. This, it was hoped, would lessen the damage to the heart by aortic regurgitation. A plastic valve was then placed in the opened descending aorta, tied into place and, when it functioned well, closure of the operative site was made. Following opera-

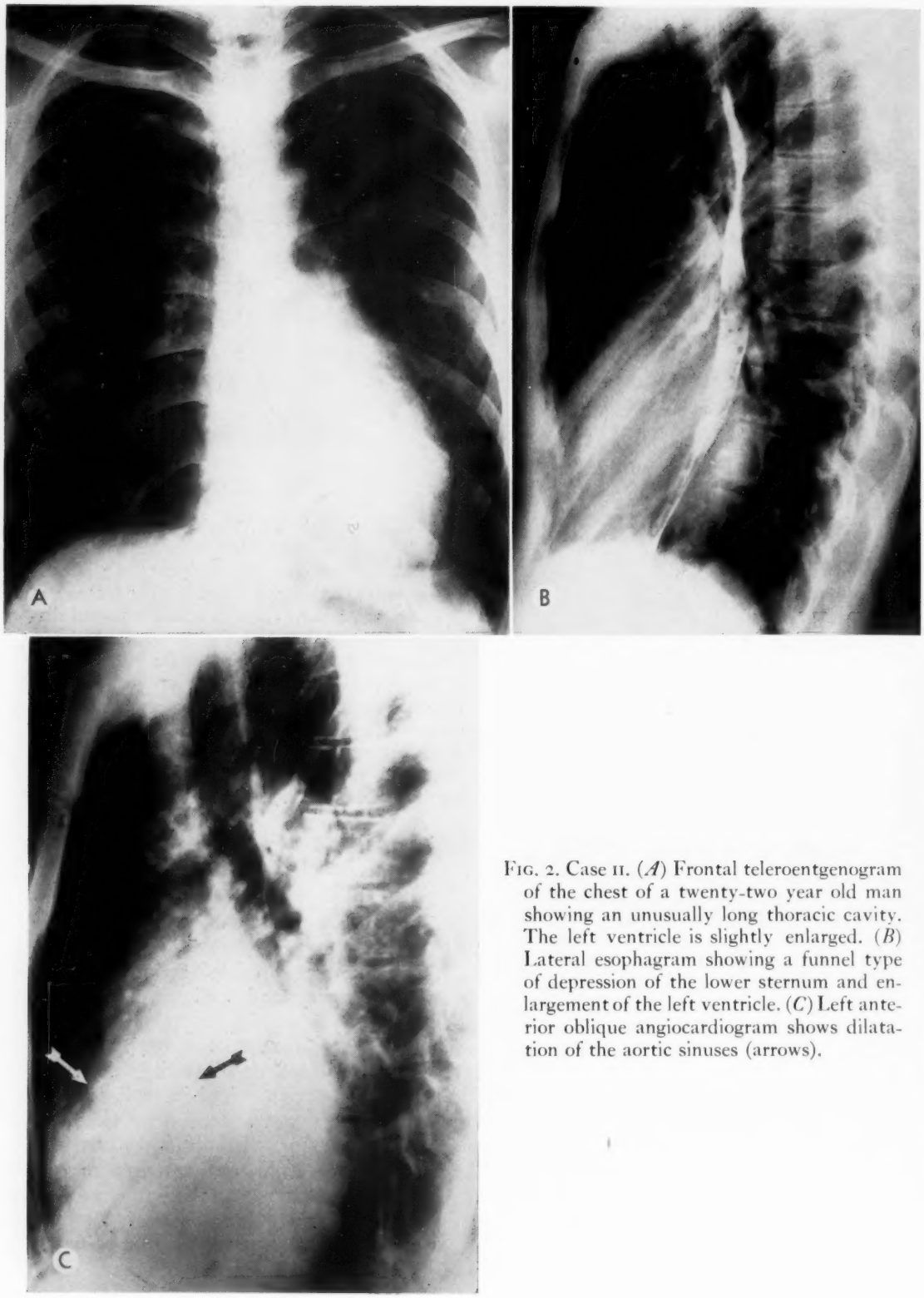

FIG. 2. Case II. (*A*) Frontal teleroentgenogram of the chest of a twenty-two year old man showing an unusually long thoracic cavity. The left ventricle is slightly enlarged. (*B*) Lateral esophagram showing a funnel type of depression of the lower sternum and enlargement of the left ventricle. (*C*) Left anterior oblique angiocardiogram shows dilatation of the aortic sinuses (arrows).

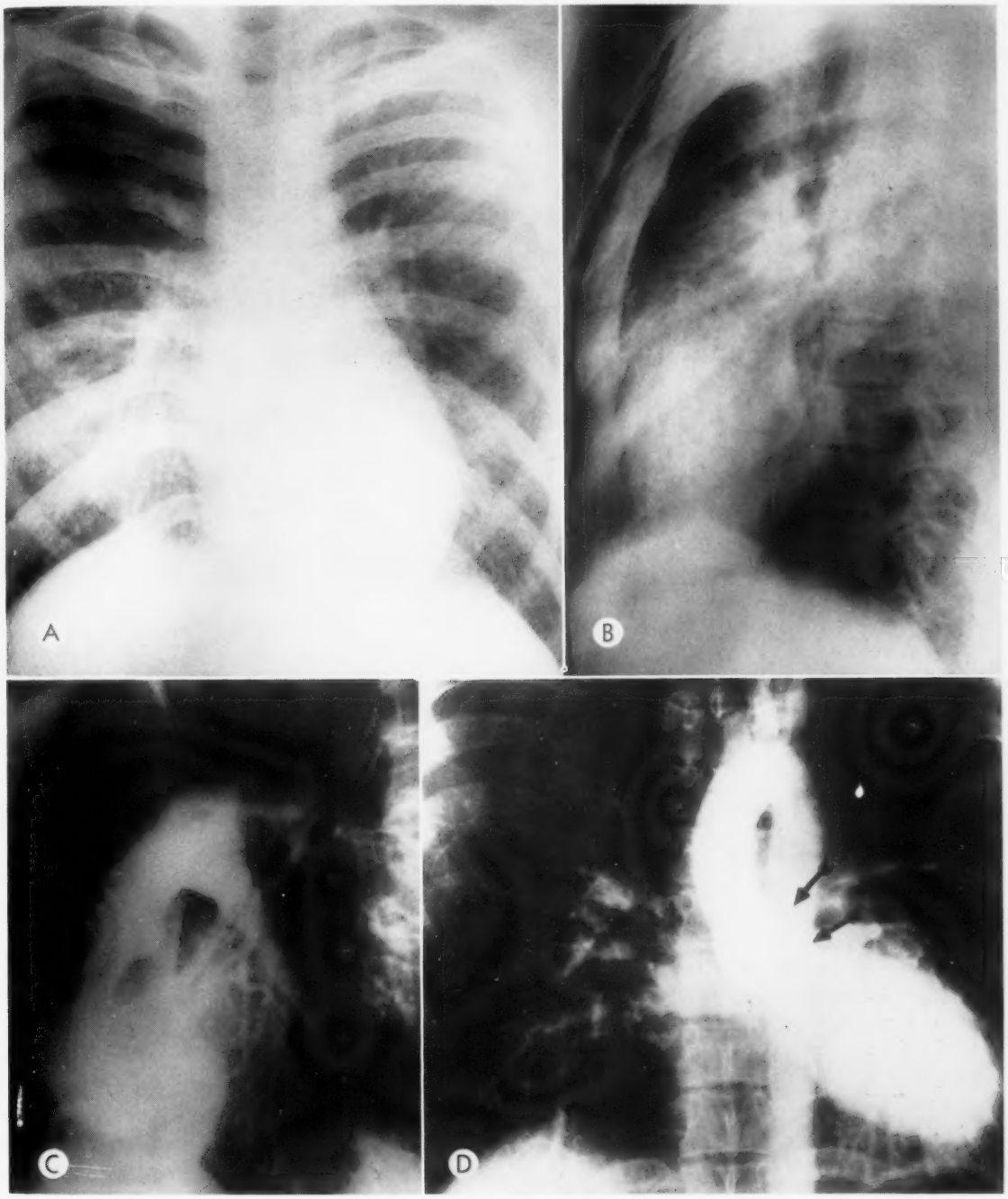

FIG. 3. Case III. (*A*) Frontal teleroentgenogram of the chest of a twenty-four year old man showing slight enlargement of the left ventricle. (*B*) Lateral teleroentgenogram shows the deformity of the lower sternum. (*C*) Lateral angiocardiogram shows a moderately sized filling defect posterior to the pulmonary conus. (*D*) Frontal angiocardiogram reveals moderate dilatation of the aortic sinuses (arrows).

tion the patient had recurrent attacks of chest pain with large quantities of hemorrhagic left pleural effusion but these soon subsided. On February 3, 1958, a mass, larger than the plastic valve, was recognized adjacent to the arch of the aorta (Fig. 4, *E* and *F*). However, the patient continued to improve and was discharged on February 19, 1958.

On April 20, 1958, he was re-admitted following sudden onset of severe abdominal pain and

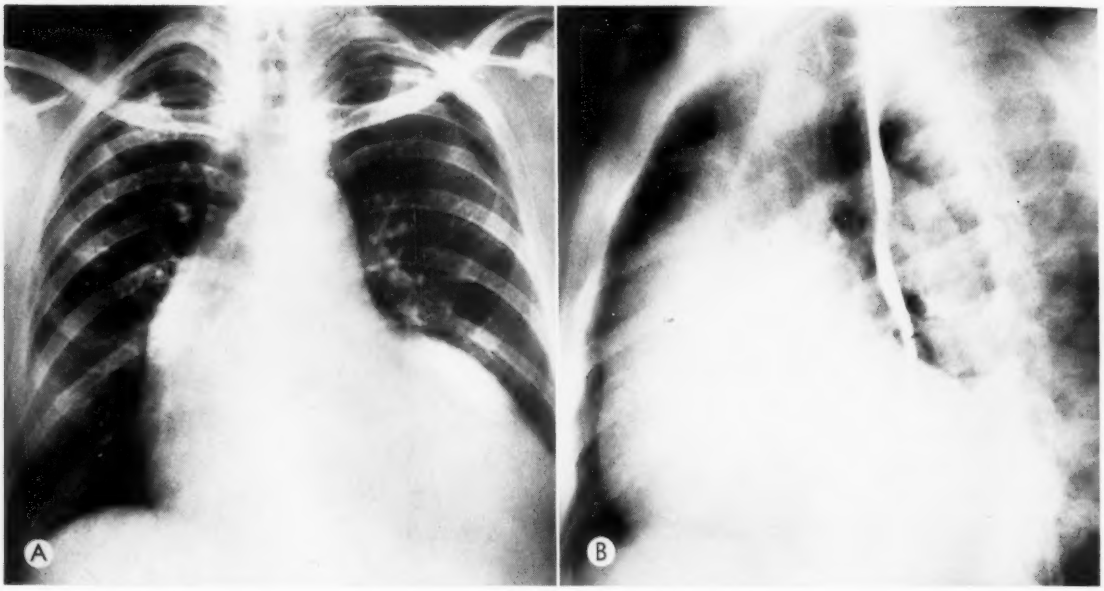

FIG. 4. Case IV. (*A*) Frontal roentgenogram of the chest of a thirty-nine year old man showing a markedly enlarged heart, chiefly the left ventricle, and a tremendously dilated ascending aorta. (*B*) Esophagram also shows the huge left ventricle and markedly widened ascending aorta.

pain and coldness of the left leg calf. A week later, severe retrosternal pain developed which lasted twelve hours and then recurred becoming constant two days later. Suddenly, on May 1, 1958, the patient had a large hemoptysis and expired.

Autopsy examination was made by Dr. Nelson D. Holmquist. The ascending aorta was markedly dilated beginning at the aortic ring and reaching up to the innominate artery. It measured 9.5 cm. in diameter (Fig. 4*G*). The aortic valve ring was also markedly dilated and measured 10.5 cm. in circumference. Some arteriosclerotic plaques were seen in the intima of the ascending aorta but these were fewer than in the abdominal aorta. The commissures of the right and left coronary cusps of the aortic valve were fenestrated; the other was slightly separated. The heart was markedly enlarged and weighed 900 gm. The left ventricle was hypertrophied measuring 20 mm. in thickness and was dilated. Microscopically, there was marked disorganization of the elastic lamella in the media of the aorta, most pronounced in the ascending portion, where there was frequent disruption of the elastic tissue with formation of clusters of smooth muscle, collagen and mucin (Fig. 4*H*). In other areas the lamellae were condensed and thickened.

The descending aorta at the site of the upper part of the Hufnagel valve was ruptured; the rent measured 5 mm. There was also a large thrombus in the superior portion of the Hufnagel valve. The left pleural sac contained 1,250 cc. of clotted blood. A 3 mm. rupture of the posterior muscular portion of the left main bronchus formed a bronchopleural fistula and caused filling of the bronchi of the left lung with clotted blood. There was also parenchymal hemorrhage. Thromboembolism of the renal arteries and small recent infarcts of the kidneys were also present. A large recent splenic infarct measured 11×12×5 cm.

CASE V. A nine year old boy (N.Y.H. No. 785767) was admitted on January 17, 1958, because of mental retardation and multiple congenital, chiefly genitourinary, anomalies. The patient was born after an uncomplicated pregnancy; the delivery was atraumatic. Cyanosis was present at birth and he required oxygen for a short time. Then for forty-eight hours there was fever up to 41°C. which subsided after penicillin therapy. On discharge from the hospital, the patient appeared well but during the first year mental retardation, cardiac murmur, hypospadias, deformities of the feet as well as long spidery fingers and toes were noted. Tests two years prior to admission had revealed the patient to be a moron with growth measured at the level of only ten months.

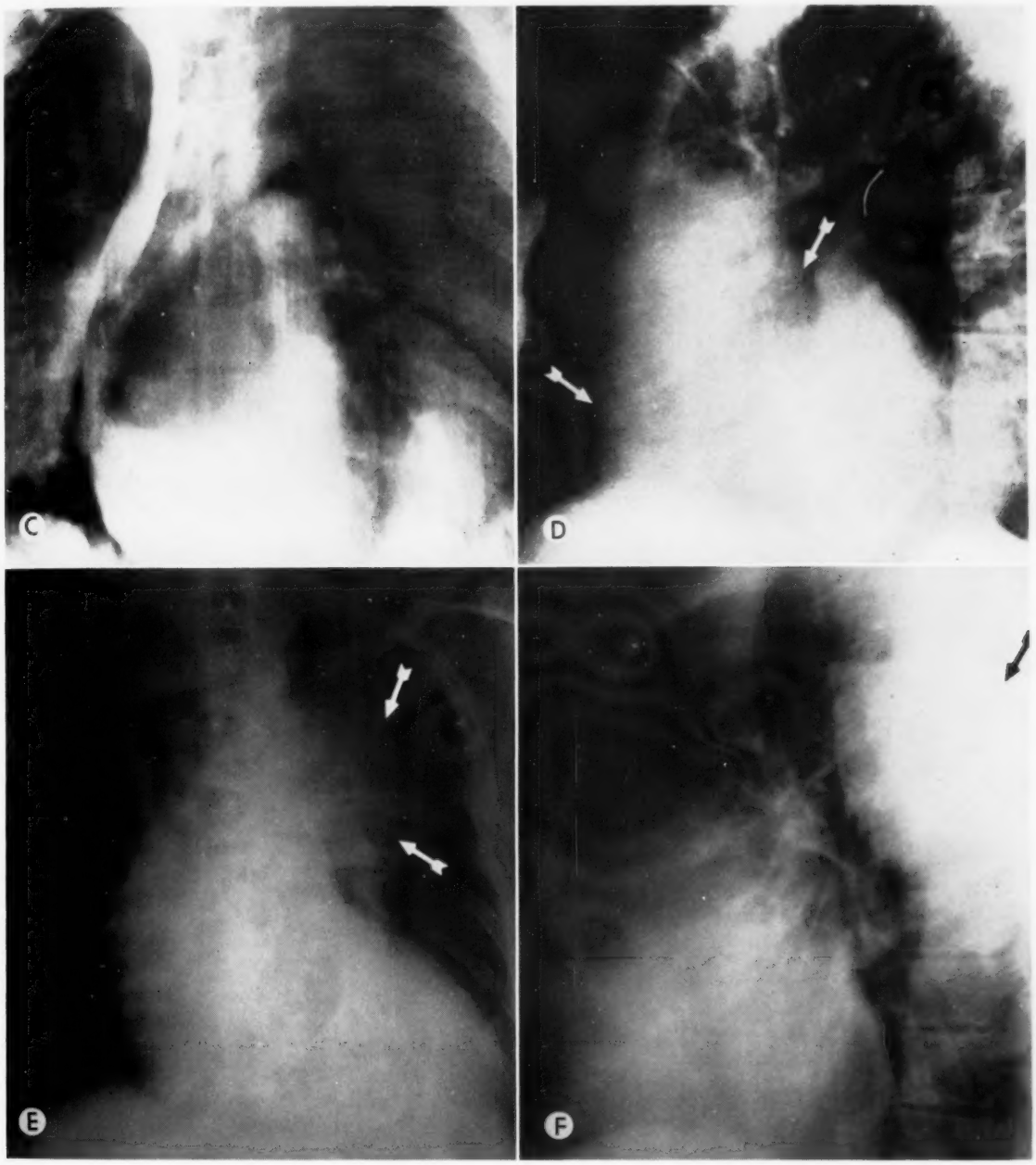

Fig. 4. Case IV. (*C*) Frontal angiocardiogram readily discloses the marked filling defect of the superior portion of the right atrium, superior vena cava and pulmonary conus. (*D*) Left anterior oblique angiocardiogram made at nineteen seconds shows an enlarged left ventricle and the markedly dilated ascending aorta that includes the aortic sinuses (arrows). (*E*) Following insertion of a Hufnagel valve, a hematoma developed (arrows). (*F*) Lateral view shows widening of the descending aorta at the site of the plastic valve (arrow).

The patient was tall (5 feet, 2 inches) and thin (weight, 46 pounds) (Fig. 5*A*); the toes and fingers were markedly elongated (Fig. 5, *B* and *C*). There was a harsh, low pitched, systolic (grade 2) murmur over the entire precordium, loudest at the third left sternal border. A short, blowing, high pitched, early diastolic (grade 2) murmur was also present over the aortic area and was transmitted along the left sternal border. Roentgen studies of the feet and hands showed unduly elongated digits (Fig. 5, *D* and *E*). Roentgenoscopic and roentgeno-

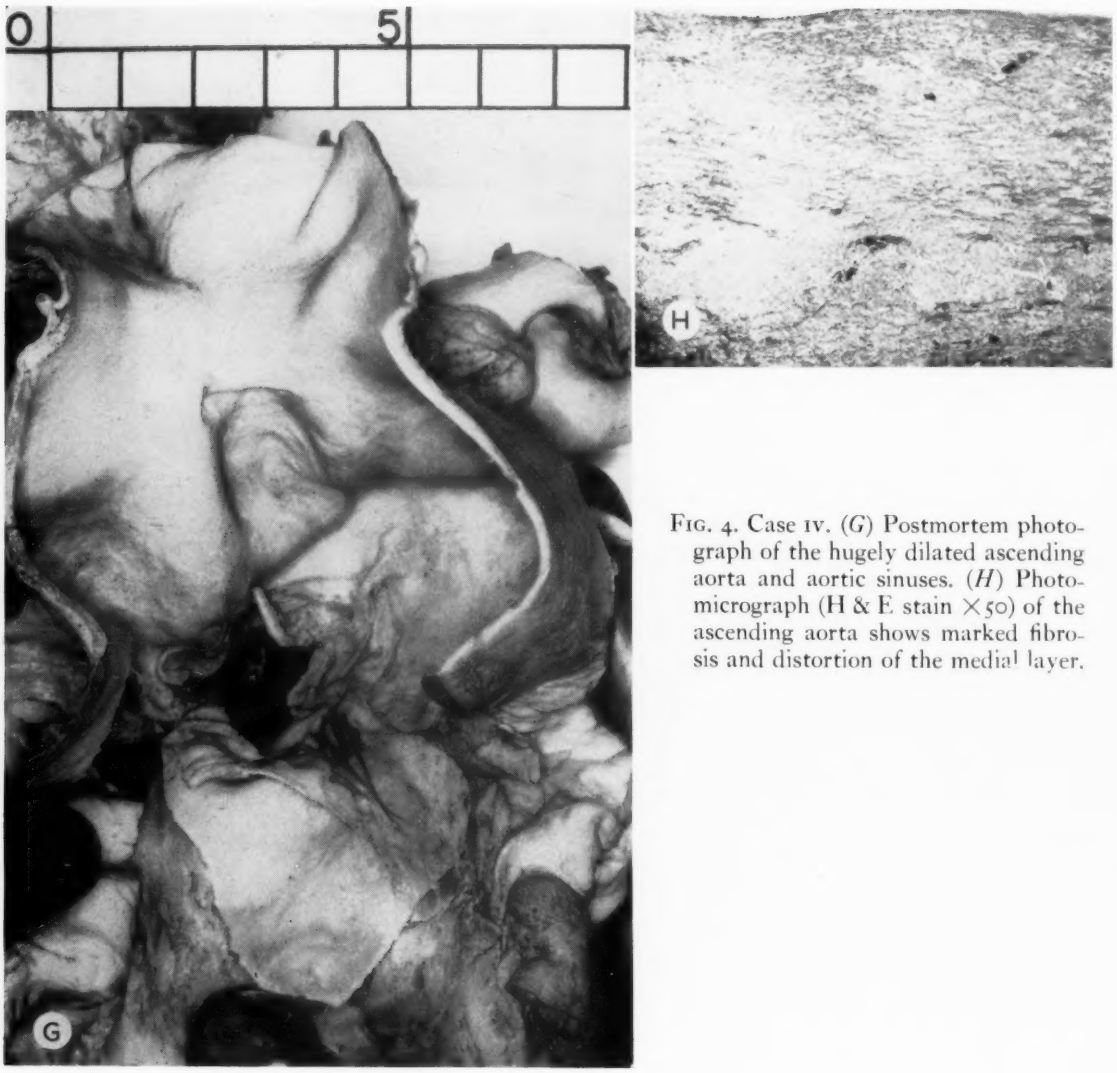

FIG. 4. Case IV. (*G*) Postmortem photograph of the hugely dilated ascending aorta and aortic sinuses. (*H*) Photomicrograph (H & E stain ×50) of the ascending aorta shows marked fibrosis and distortion of the medial layer.

graphic studies of the heart revealed a hugely dilated ascending aorta and a slightly enlarged left ventricle (Fig. 5*F*). The blood pressure was 110/85 mm. Hg. The electrocardiogram was normal; ophthalmologic studies were also normal.

Urologic studies revealed an atrophic right kidney with marked (grade 4) hydronephrosis and hydroureter on the left side, and with obstruction of the bladder neck. Suprapubic cystostomy and left nephrostomy were done for relief of the urinary obstruction. However, fever and pyuria persisted although the patient improved sufficiently to be discharged on February 15, 1958. Re-admission on March 17, 1958, disclosed failure of drainage of the left nephrostomy tube. Therefore, left cutaneous ureterostomy was performed and the urinary flow re-established, but fever, varying from 39 to 40°C. recurred daily and the patient became unable to eat or drink, requiring intravenous fluids. Finally, high levels of blood urea nitrogen developed and the patient died on March 24, 1958.

Autopsy examination by Dr. Nelson D. Holmquist revealed dilatation and hypertrophy of the bladder, bilateral hydroureter, hydronephrosis and left pyelonephrosis. There was no obstruction of the ureteral orifices. The right kidney was small and consisted of a thin fibrous shell surrounding a dilated pelvis and calyces. The left kidney was markedly enlarged and had a greatly dilated and thickened pelvis and calyces. The normal architecture of the left

kidney was destroyed and there was a thick adherent capsule. Microscopic sections of this kidney revealed chronic pyelonephritis with considerable amount of normal parenchyma in some areas. The right kidney was mainly a fibrous shell. There was also hypospadias of the glans penis with the urethral orifice opening on the under surface. Bronchopneumonia of the right upper and lower lobes was also present.

The heart weighed 120 gm. (expected weight, 115 gm.). The left ventricle was 10 mm. in thickness. The aortic sinuses were large and the arch of the aorta was strikingly dilated and measured 6.8 cm. in circumference. The aortic valves were bicuspid and exhibited thickening and considerable separation of the commissures (Fig. 5*G*). A patent ductus arteriosus (2 mm. in diameter) was also present. Microscopic sections of the dilated ascending aorta and valve cusps showed an abnormal media consisting of flattened, unevenly distributed and condensed elastic fibers which surrounded masses of collagen and smooth muscle fibers (Fig. 5*H*).

Fig. 5. Case v. (*A*) Photograph of a nine year old boy with Marfan's syndrome. Drainage tubes over the abdomen, pelvis and thighs connect with the bladder and left kidney.

DISCUSSION

Marfan's syndrome is a rare hereditary disease of connective tissue transmitted as a simple mendelian dominant trait.[24] Marfan,[23] in 1896, described the first case and called attention to the long thin spider-like appearance of the extended extremities, a characteristic feature of the disease that has become known as arachnodactyly.[3] The experimental production of kyphoscoliosis, periosteal new bone formation, and dissecting aneurysms of the aorta in growing rats fed diets containing 50 per cent sweet pea seeds is believed to be due to defective formation or excessive destruction of the ground substance. The presence of similar lesions in arachnodactyly suggests that the metabolism of one of the essential proteins of the ground substance may have a hereditary defect.[6,9,29,45]

The patients with classic Marfan's syndrome can often be recognized at a glance. They are unusually tall and lanky with dangling, thin, spider-like limbs. In addition to dolichocephalic skulls, the ears are often long and large; the long faces topped by heavy thick glasses give them a wise and prematurely old appearance. Skeletal deformities due to poorly developed and relaxed ligaments, subcutaneous tissues, and muscles cause spinal and thoracic deformities such as scoliosis, kyphosis, funnel and pigeon breast. Hyperextension and "double jointedness" of the extremities are common. Ocular abnormalities are also prevalent occurring in up to 80 per cent of the cases.[30] Congenital bilateral dislocation of the lenses due to poor ligamentous support and myopia cause serious progressive deterioration in vision.

Over 400 cases of arachnodactyly have been reported. The incidence of cardiovascular involvement is uncertain, but is estimated as being 30 to 60 per cent. The clinical and cardiovascular

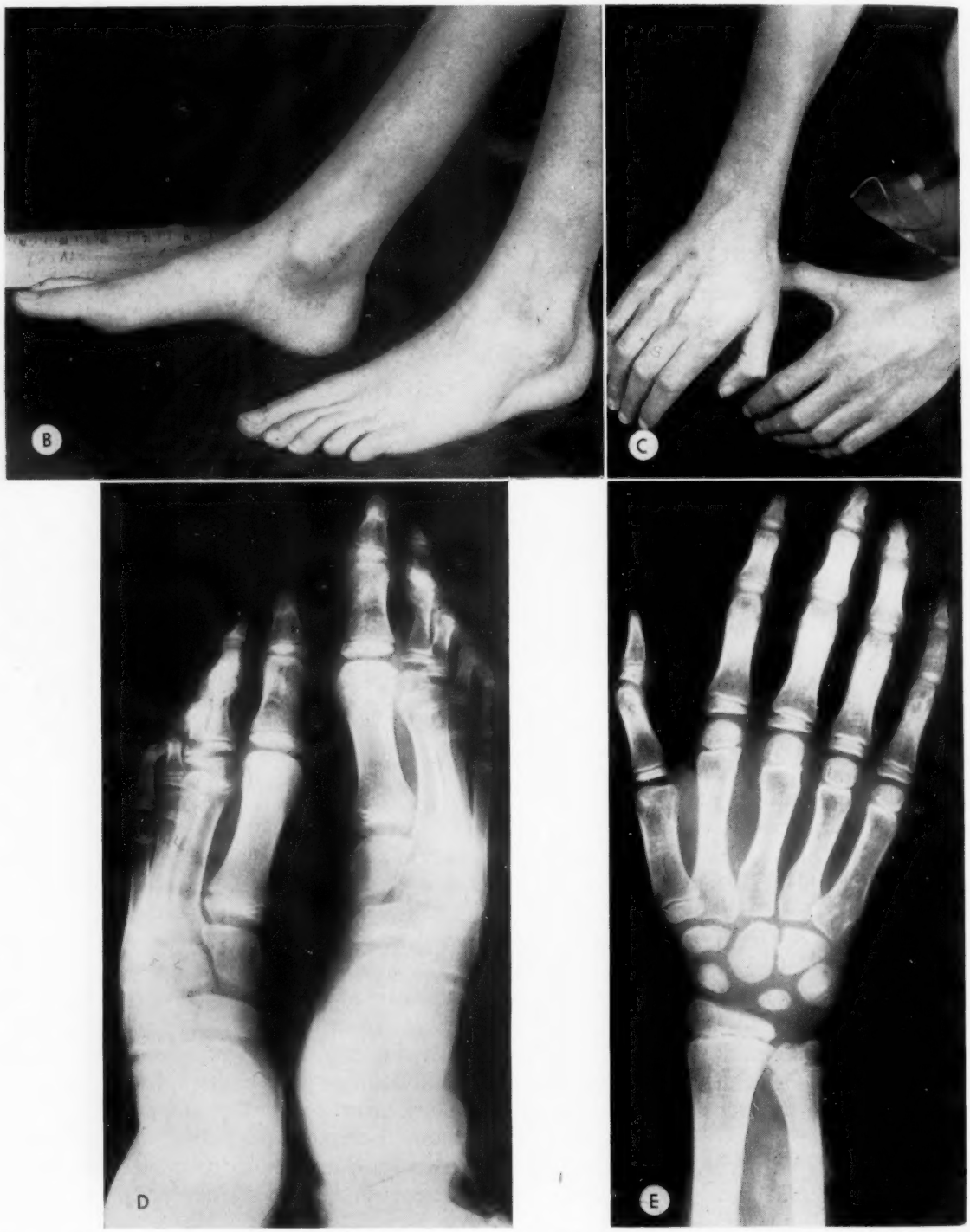

Fig. 5. Case v. (*B*) Photograph showing unusually long feet. (*C*) Photograph showing long fingers. (*D*) Roentgenogram of the feet showing elongated bones. (*E*) Roentgenogram of the left hand showing long fingers.

manifestations of arachnodactyly have been thoroughly reviewed in the literature.[2,15,17–19,22,24,25,27,28,31,32,37] Baer, Taussig and Oppenheimer[4] were the first to call attention to cardiovascular involvement at necropsy, medial degeneration of the aorta producing aneurysmal dilatation of the ascending aorta, endocardial valvular thickening, and marked cardiac hypertrophy. Reports of sudden death due to rupture of dissecting aneurysms then followed, and these overshadowed the cases that had dilatation of the aortic ring, aortic dilatation, aortic regurgitation, angina and heart failure.[18] Involvement of the aortic sinuses was only occasionally described at autopsy.[32,37] Medial degeneration, aneurysmal dilatation and rupture of the pulmonary artery have also been recorded.[2,17,24,31,42]

Endocardial lesions were reported in over two-thirds of the autopsied cases and involved the mitral valve more often than the aorta, although combined lesions of both valves were frequent.[17] Fibromyxomatous (fenestration) valvular thickening has also been a common finding but is not peculiar to arachnodactyly.[22,27,31,42] It produces deformities of the valves and may be responsible for murmurs. Often the auscultatory findings are attributed to rheumatic fever. Necropsy studies, however, do not reveal the changes of rheumatism.[17,24,31,42]

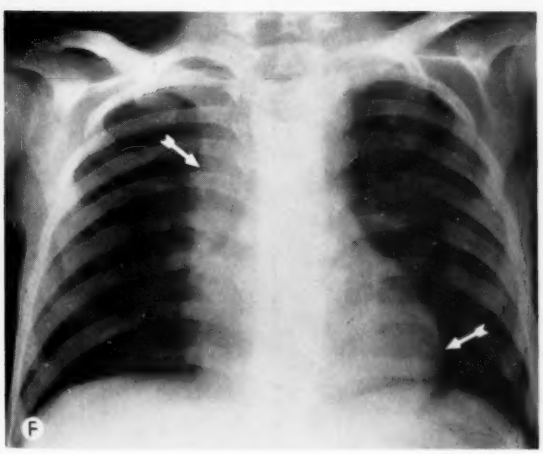

Fig. 5. Case v. (*F*) Frontal roentgenogram shows slight enlargement of the heart (arrow) and huge dilatation of the ascending aorta (arrow).

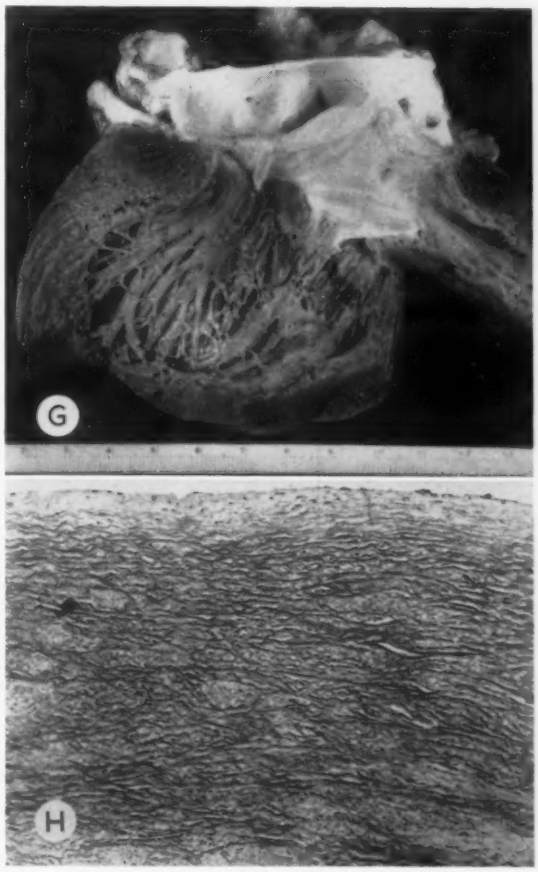

Fig. 5. Case v. (*G*) Postmortem photograph of the heart shows a markedly dilated ascending aorta, bicuspid valve and dilatation of the aortic sinuses. The left ventricle is slightly thickened. (*H*) Photomicrograph (H & E stain ×150) shows islands of fibrous tissue in the distorted medial coat of an aortic valve cusp.

Cardiac enlargement has been a constant finding.

In a series of 10 cases with dilatation of the aortic sinuses (Table 1), 3 patients had aortic valvular insufficiency (Case iv, v, and vii). Griffin and Koman[18] have recently reviewed the subject of aortic insufficiency in Marfan's syndrome. The seven other patients had apical systolic murmurs that may be related to the dilatation of the aortic sinuses or else are due to associated left ventricular endocardial or subendocardial disease. The ages of the ten patients varied from two to forty-seven years. Six were males and 4 were females. All were Caucasian.

TABLE I

CLINICAL AND ROENTGEN FINDINGS IN MARFAN'S SYNDROME WITH DILATATION OF THE AORTIC SINUSES

Case and Reference			Symptoms	Skeletal Defects	Eye Defects	Family History	Cardiac Murmurs	Blood Pressure in mm. Hg	ECG	Cardiac Silhouette	Angiocardiography			Remarks and Follow-up
No.	Age	Sex									Ascending Aorta in mm.	Horizontal Measurement of Aortic Sinus	Heart	
I	23	F	None	+ (Fig. 1*A*)	+	o	Systolic apical	120/80	Negative	Normal (Fig. 1, *B* and *C*)	30	40	N (Fig. 1, *E* and *F*)	Continues to be asymptomatic
II	22	M	None	+	o	o	Systolic and diastolic at apex	126/75	Lad.	Enlarged left ventricle (Fig. 2, *A* and *B*)	23	42	Slightly enlarged left ventricle (Fig. 2*C*)	Continues to be asymptomatic
III	24	M	None	+	o	o	Systolic apical	116/80	Negative	Slight enlargement of left ventricle (Fig. 3, *A* and *B*)	25	40	N (Fig. 3*D*)	Neurofibromatosis of skin. Continues to be asymptomatic
IV	39	M	Dyspnea, heart failure	+	+	+	Aortic insufficiency	150/45	Left ventricular hypertrophy	Enlarged left ventricle and dilatation of the ascending aorta (Fig. 4, *A* and *B*)	100	90	Marked left ventricle enlargement	Hufnagel valve complicated by aortic rupture (Fig. 4, *E* and *F*) failed to alleviate relentless progress of disease. Death followed rupture of aorta at site of valve. Autopsy confirmed angiocardiogram (Fig. 4*G*). Medial degeneration of ascending aorta pronounced (Fig. 4*H*)
V	9	M	Mental deficiency; multiple anomalies with genitourinary infection	+	o	o	Aortic insufficiency, systolic apical	110/85	Negative	Enlarged heart, dilated ascending aorta (Fig. 5*C*)				Aneurysmal dilatation of ascending aorta, bicuspid aortic valves and aneurysmal dilatation of aortic sinuses at autopsy (Fig. 5*G*). Microscopically abnormal media in aortic valve (Fig. 5*H*). A small (2 mm.) silent patent ductus arteriosus also present

TABLE I—(*Continued*)

Case and Reference No.	Age	Sex	Symptoms	Skeletal Defects	Eye Defects	Family History	Cardiac Murmurs	Blood Pressure in mm. Hg	ECG	Cardiac Silhouette	Angiocardiography: Ascending Aorta in mm.	Angiocardiography: Horizontal Measurement of Aortic Sinus	Angiocardiography: Heart	Remarks and Follow-up
VI[32]	40	M	None	+	+	+	Systolic apical	130/70	Negative	Enlarged left ventricle	38	65	Enlarged left ventricle	Began to fibrillate one year previously and had bout of heart failure; digitalized and working now
VII[32]	47	F	Severe chest pain, dyspnea, weakness	+	+	o	Aortic insufficiency; presystolic at apex	140/60	Lad. and left ventricular hypertrophy	Enlarged left ventricle	30	65	Enlarged left ventricle	Died twenty-two months after diagnosis. No autopsy
VIII[32]	23	M	None	+	+	o	Systolic apical	120/60	Partial heart block	Normal	40	50	Normal	Working, no change in murmurs or heart size, three years
IX[27]	2	F	None	+	+	+	Systolic in mitral area	96/60	Lad. and left ventricular hypertrophy	Enlarged left ventricle	18	30	Enlarged left ventricle	Continues asymptomatic without change in ECG and heart size
X[27]	2	F	None	+	+	+	Systolic apical	100/60	Lad. and left ventricular hypertrophy	Enlarged left ventricle	18	25	Enlarged left ventricle	Recently re-hospitalized for increased heart size. Apical systolic murmur louder

ECG = electrocardiogram.
+ = present.
o = absent.
Lad. = left axis deviation.
N = normal.

There were 3 deaths in the series. Two patients (Case IV and VII) had congestive heart failure associated with severe aortic insufficiency. The immediate cause of death in one of these (Case IV) was rupture of the aorta at the site of insertion of a plastic valve, performed in the hope of delaying the relentless effects of the aortic regurgitation. The third patient (Case V) died of uremia before significant enlargement of the heart and congestive heart failure had developed. At autopsy a bicuspid valve and separation of the commissures were found to be responsible for the aortic insufficiency.

Seven patients were asymptomatic, and of these, 3 (Case I, VI, and VIII) were studied angiocardiographically to determine the presence of cardiovascular disease. In the 4 other cases (Case II, III, IX and X), cardiac murmurs and enlargement of the heart led to the special studies. Cardiac catheterization was done in 3 patients (Case III, IX and X).

Skeletal defects were present in all of the 10 patients; eye abnormalities were found in all but 2 (Table 1). In 6 instances, family histories of Marfan's syndrome could not be elicited. However, when examinations of parents, siblings and next of kin were made, the stigmata of Marfan's syndrome were evident. For instance, in the family with the set of twins (Case IX and X) 4 siblings and the father had enlarged hearts, cardiac murmurs, eye lesions and skeletal deformities, emphasizing the importance of the familial character of the disorder.[7,24]

As expected, the blood pressure and electrocardiographic findings (Table 1) reflected the degree of cardiac involvement. Two patients with aortic regurgitation (Case IV and VII) had low diastolic pressures. Case V, in which clinical signs of aortic insufficiency were noted, was found to have a bicuspid valve at autopsy, but the insufficiency had not progressed enough to alter the pulse pressure. Four patients had normal electrocardiograms; one each, respectively, had left axis deviation (Case II) and partial heart block (Case VIII); the others showed left ventricular hypertrophy (Case IV, VII, VIII and IX).

Conventional roentgenography of the chest readily disclosed thoracic cage deformities (Fig. 1*C*, 2*B* and 3*B*). Cardiac enlargement was evident in 8 patients (Fig. 2*A*, 3*A*, 4*A* and 5*F*). Roentgenography also revealed the abnormally long thoracic cavities (Fig. 1, *B* and *C*, 2, *A* and *B*, and 3, *A* and *B*) as well as the long fingers and toes Fig. 5, *D* and *E*).

Angiocardiography provided the definitive method of demonstrating dilatation of the aortic sinuses. In one instance, confirmed by autopsy (Fig. 4*G*), the enormous aneurysmal dilatation of the ascending aorta was also found to involve the aortic sinuses (Fig. 4*C*). In the others (Fig. 1, *E* and *F*, 2*C* and 3*D*) as well as in some of the previously reported cases[32,37] dilatation of the aortic sinuses appeared to be an isolated lesion, although in 2 patients (Case VI and VIII) the mid-ascending aorta measured 38 and 40 mm., a figure which has been established as the upper limits of normal.[11,12] The horizontal diameter of the aortic sinuses (Table 1) exceeded the average measurements of 30–38 mm. established in a recent publication.[13] The horizontal diameter of the aortic sinus in Cases IX and X measured only 30 and 25 mm., respectively. However, normal standards are not available in infants and children.

Not all patients with manifestations of cardiovascular disease and Marfan's syndrome have aortic sinus dilatation. In 8 additional cases with Marfan's syndrome, lesions such as aortic stenosis with poststenotic dilatation of the ascending aorta, coarctation of the aorta and cardiac enlargement were demonstrated by angiocardiography. Recently, Keith *et al.*[20] described dilatation of the pulmonary artery root in Marfan's syndrome. In a series of 18 cases studied angiocardiographically, only one, a ten year old patient, had dilatation of the pulmonary artery but this was associated with generalized cardiac enlargement due to heart failure.

Marfan's syndrome accounts for a large number of the congenital unperforated aortic sinus dilatations reported from this center.[33–37] Since aneurysmal dilatations of the aortic sinuses and coarctation of the aorta are often associated,[13,39] the differential diagnosis and exclusion of Marfan's syndrome will depend upon the finding of ocular and skeletal deformities and a familial history of Marfan's syndrome. Acquired aortic sinus aneurysms due to syphilis may be differentiated by serologic tests.[26] Syphilitic aneurysms of the sinus of Valsalva also tend to be larger; the huge size of the ascending aorta and aortic sinuses in Case IV appears to be exceptional. Arteriosclerotic dilatation of the aortic sinuses associated with aortic dilatation has been recognized only once.[38]

In the literature there are 2 other reports of attempts to allay the ravages of aortic insufficiency and heart failure in Marfan's syndrome by the installation of a Hufnagel valve.[8,10] These, as in Case IV, failed and it would appear that the medially degenerated aorta of Marfan's syndrome is probably unsuited for palliative or reparative surgery.[14] Bahnson[5] also failed to suture a huge ascending aortic aneurysm with aortic sinus dilatation in a patient with Marfan's syndrome.

SUMMARY AND CONCLUSIONS

Angiocardiography by visualizing the thoracic aorta provides the definitive method of demonstrating the aortic sinuses. Dilatation of the aortic sinus is probably not uncommon in Marfan's syndrome; 9 patients with Marfan's syndrome were shown to have uniform dilatations of the aortic sinuses. In one, the aortic sinus dilatation was aneurysmal and was associated with huge dilatation of the ascending aorta.

In over one-half of the cases in a series of 10 patients with Marfan's syndrome, cardiac murmurs and enlargement of the heart were the presenting findings. Angiocardiography, by demonstrating aortic sinus dilatation, revealed the cardiovascular abnormality and in some instances provided the clue that linked the associated skeletal and ocular deformities.

Marfan's syndrome is probably not as rare as previously supposed. The radiologist by noting the unusually long and thin extremities, especially the fingers and toes, thoracic deformities, and cardiovascular abnormalities may be the first to suggest the diagnosis, and thereby explain seemingly unrelated findings. The *forme fruste* type of Marfan's syndrome should be kept in mind whenever there is aneurysmal dilatation of the aortic sinuses or ascending aorta.

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ADDENDUM

Since this paper was submitted for publication two articles calling attention to the *forme fruste* (aborted or atypical) type of the Marfan syndrome have been published. 1. GOLDEN, R. L., and LAKIN, H. The forme fruste in Marfan's syndrome. *New England J. Med.*, 1959, *260*, 797–801; and 2. WEAVER, W. F., EDWARDS, J. E., and BRANDENBURG, R. O. Idiopathic dilatation of the aorta with aortic valvular insufficiency: a possible forme fruste of Marfan's syndrome. *Proc. Staff Meet. Mayo Clin.*, 1959, *34*, 518–522.

REFERENCES

1. AMUNDSEN, P., and HOLTER, I. Cardiovascular changes in dystrophia mesodermalis congenita Marfan. *Acta radiol.*, 1956, *45*, 365–370.
2. ANDERSON, M., and PRATT-THOMAS, H. R. Marfan's syndrome. *Am. Heart J.*, 1953, *46*, 911–917.
3. ARCHAND, M. C. Arachnodactylie. *Bull. et mém. Soc. méd. hôp. Paris*, 1902, *19*, 834–840.
4. BAER, R. W., TAUSSIG, H. B., and OPPENHEIMER, E. H. Congenital aneurysmal dilatation of aorta associated with arachnodactyly. *Bull. Johns Hopkins Hosp.*, 1943, *72*, 309–317.
5. BAHNSON, H. T., and NELSON, A. R. Cystic medial necrosis as cause of localized aortic aneurysms amenable to surgical treatment. *Ann. Surg.*, 1956, *144*, 519–529.

6. BEAN, W. B., and PONSETI, I. V. Dissecting aneurysm produced by diet. *Circulation*, 1955, *12*, 185–192.
7. BLACK, H. H., and LANDAY, L. H. Marfan's syndrome; report of five cases in one family. *A.M.A. Am. J. Dis. Child.*, 1955, *89*, 414–420.
8. Case Records of the Massachusetts General Hospital. Case #43011. *New England J. Med.*, 1957, *256*, 30–36.
9. DASLER, W. Experimental lathyrism. *Chicago M. School Quarterly*, 1957, *18*, 1–10.
10. DIMOND, E. G., LARSEN, W. E., JOHNSON, W. B., and KITTLE, C. F. Post-traumatic aortic insufficiency occurring in Marfan's syndrome, with attempted repair with plastic valve. *New England J. Med.*, 1957, *256*, 8–11.
11. DOTTER, C. T., and STEINBERG, I. Angiocardiographic measurement of normal great vessels. *Radiology*, 1949, *52*, 353–358.
12. DOTTER, C. T., and STEINBERG, I. Angiocardiography. Paul B. Hoeber, Inc., New York, 1951.
13. DUBILIER, W., JR., TAYLOR, T. L., and STEINBERG, I. Aortic sinus aneurysm associated with coarctation of aorta. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1955, *73*, 10–14.
14. Editorial. Marfan's syndrome. *New England J. Med.*, 1957, *256*, 39.
15. ETTER, L. E., and GLOVER, L. P. Arachnodactyly complicated by dislocated lenses and death from rupture of dissecting aneurysm of aorta. *J.A.M.A.*, 1943, *123*, 88–89.
16. GORE, I. Dissecting aneurysm of aorta in persons under forty years of age. *A.M.A. Arch. Path.*, 1953, *55*, 1–13.
17. GOYETTE, E. M., and PALMER, P. W. Cardiovascular lesions in arachnodactyly. *Circulation*, 1953, *7*, 373–379.
18. GRIFFIN, J. F., and KOMAN, G. M. Severe aortic insufficiency in Marfan's syndrome. *Ann. Int. Med.*, 1958, *48*, 174–187.
19. HUSEBYE, K. O., WOLFF, H. J., and FREIDMAN, L. L. Aortic dissection in pregnancy: case of Marfan's syndrome. *Am. Heart J.*, 1958, *55*, 662–676.
20. KEITH, J. D., ROWE, R. D., and VLAD, P. Heart Disease in Infancy and Childhood. The Macmillan Company, New York, 1958.
21. LILLIAN, M. Multiple pulmonary artery aneurysms; endarteritis of ductus arteriosus and congenital pulmonary cysts. *Am. J. Med.*, 1949, *7*, 280–287.
22. MACLEOD, M., and WILLIAMS, A. W. Cardiovascular lesions in Marfan's syndrome. *Arch. Path.*, 1956, *61*, 143–148.
23. MARFAN, A. B. Un cas de déformation congénitale des quatre membres, plus prononcée aux extrémités, caracterisée par l'allongement des os avec un certain degré d'amincissement. *Bull. et mém. Soc. méd hôp. Paris*, 1896, *13*, 220–226.
24.(a) MCKUSICK, V. A. Cardiovascular aspects of Marfan's syndrome: heritable disorder of connective tissue. *Circulation*, 1955, *11*, 321–243.
(b) Genetic aspects of cardiovascular diseases. *Ann. Int. Med.*, 1958, *49*, 556–567.
25. MARVEL, R. J., and GENOVESE, P. D. Cardiovascular disease in Marfan's syndrome. *Am. Heart J.*, 1951, *42*, 814–825.
26. MERTEN, C. W., FINBY, N., and STEINBERG, I. Antemortem diagnosis of syphilitic aneurysm of aortic sinuses; report of nine cases. *Am. J. Med.*, 1956, *20*, 345–560.
27. MOSES, M. F. Aortic aneurysm associated with arachnodactyly. *Brit. M. J.*, 1951, *2*, 81–84.
28. PAPPAS, E. G., MASON, D., and DENTON, C. Marfan's syndrome: report of three patients with aneurysm of aorta. *Am. J. Med.*, 1957, *23*, 426–433.
29. PONSETI, I. V., with assistance of SHEPARD, R. S. Lesions of skeleton and other mesodermal tissues in rats fed sweet-pea (Lathyrus odoratus) seeds. *J. Bone & Joint Surg.*, 1954, *36-A*, 1031–1058.
30. RADOS, A. Marfan's syndrome; arachnodactyly coupled with dislocation of lens. *Arch. Ophth.*, 1942, *27*, 477–538.
31. SLOPER, J. C., and STOREY, G. Aneurysm of ascending aorta due to medial degeneration associated with arachnodactyly (Marfan's disease). *J. Clin. Path.*, 1953, *6*, 299–303.
32. STEINBERG, I., and GELLER, W. Aneurysmal dilatation of aortic sinuses in arachnodactyly: diagnosis during life in three cases. *Ann. Int. Med.*, 1955, *43*, 120–132.
33. STEINBERG, I., and FINBY, N. Congenital aneurysm of right aortic sinus associated with coarctation of aorta and subacute bacterial endocarditis; antemortem report of case. *New England J. Med.*, 1955, *253*, 549–552.
34. STEINBERG, I. Aneurysm of aortic sinuses with pseudocoarctation of aorta. *Brit. Heart J.*, 1956, *18*, 85–89.
35. STEINBERG, I., and FINBY, N. Clinical manifestations of unperforated aortic sinus aneurysm. *Circulation*, 1956, *14*, 115–124.
36. STEINBERG, I., and FINBY, N. Roentgen manifestations of unperforated aortic sinus aneurysms; report of three new cases. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1957, *77*, 263–273.
37. STEINBERG, I., MANGIARDI, J. L., and NOBLE, W. J. Aneurysmal dilatation of aortic sinuses in Marfan's syndrome; angiocardiographic and cardiac catheterization studies in identical twins. *Circulation*, 1957, *16*, 368–373.
38. STEINBERG, I. Aneurysms of thoracic aorta; review of diagnostic and etiologic features. *Am. J. Cardiol.*, 1958, *1*, 736–747.

39. Steinberg, I., and Sammons, B. P. Aneurysmal dilatation of aortic sinuses in coarctation of aorta; report of two new cases with review of literature. *Ann. Int. Med.*, 1958, *49*, 924–934.
40. Thomas, J., Brothers, G. B., Anderson, R. S., and Cuff, J. R. Marfan's syndrome; report of three cases with aneurysm of aorta. *Am. J. Med.*, 1952, *12*, 613–618.
41. Tobin, J. R., Bay, E. B., and Humphreys, E. M. Marfan's syndrome in adult; dissecting aneurysm of aorta associated with arachnodactyly. *Arch. Int. Med.*, 1946, *80*, 475–490.
42. Tung, H. L., and Liebow, A. A. Marfan's syndrome; observations at necropsy: with special reference to medionecrosis of great vessels. *Lab. Invest.*, 1952, *1*, 382–406.
43. Uyeyama, H., Kondo, B., and Kamins, M. Arachnodactylia and cardiovascular disease—report of autopsied case with summary of previously autopsied cases. *Am. Heart J.*, 1947, *34*, 580–591.
44. Van Bechem, F. S. Cardiovascular disease in arachnodactyly. *Acta med. scandinav.*, 1958, *161*, 197–205; and Arachnodactyly heart. *Circulation*, 1959, *20*, 80–95.
45. Walker, D. G., and Wirtschafter, Z. T. Histopathogenesis of aortic aneurysms in the Lathyrus-fed rat. *Arch. Path.*, 1956, *61*, 125–135.
46. Whittaker, S. R. F., and Sheehan, J. D. Dissecting aortic aneurysm in Marfan's syndrome. *Lancet*, 1954, *2*, 791–792.
47. Wilson, R. Marfan's syndrome: description of family. *Am. J. Med.*, 1957, *23*, 434–444.

TRANSSTERNAL PHLEBOGRAPHY OF THE INTERNAL MAMMARY VEINS*

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MILAN, ITALY

METASTATIC dissemination of cancer of the breast occurs mainly by the lymphatic route. It is, therefore, important for the surgeon to know which lymph nodes are invaded in order to be able to determine the type of operation to be performed and to formulate the prognosis which might be expected. Although the axillary and supraclavicular lymph nodes are directly accessible to palpation, the internal mammary lymph nodes, which receive the drainage of the lymph from a rather significant portion of the breast, unfortunately cannot be explored by commonly employed procedures. Yet, according to Handley and Thackray,[19] metastases to the internal mammary lymph nodes are observed in 33 per cent of all breast cancer cases, predominantly from tumors of the inner quadrants of the breast. Margottini and Bucalossi,[26] in performing radical mastectomy with excision of the internal mammary lymph nodes of the first three intercostal spaces in 110 patients, likewise found that despite the fact that they were not dealing with a larger percentage of tumors of the inner quadrants, the parasternal lymph nodes were involved by metastases in 23 per cent of the cases (of the second, third and first intercostal spaces in decreasing order). These latter authors also noted that there was no direct relationship between the incidence of metastases in this site and the histologic type of the tumor.

Giacomelli and Veronesi[14] in reviewing 161 cases examined from 1948 to 1951 found an incidence of metastases to the internal mammary lymph nodes of 24.8 per cent, with a predominance from tumors of the outer quadrants (22.7 per cent against 20 per cent of tumors of the inner quadrants). Mörl,[28] who reported an incidence of 24 per cent, also observed that metastases to the internal mammary lymph nodes occur more frequently in tumors of the outer quadrants.

Wanke,[35] like Handley and Thackray, noted that metastases to the parasternal lymph nodes were more common in carcinomas of the inner or central sites than of the outer portions of the breast. He found parasternal metastases in 11 per cent of cases classified as Steinthal's Stage I and in 40 per cent of Stage II cases.

In view of this high percentage of parasternal involvement, the question arises why radical mastectomy is not complemented routinely with excision of the internal mammary chain of lymph nodes in all cases? An answer, perhaps, may be found in the following limitations of a surgical nature: (1) Operative shock is more severe than in the case of ordinary radical mastectomy and, therefore, the status of the patient's general condition must serve as a guiding point; (2) there are differences of opinion among the various authors as to the usefulness of such an extensive procedure in regard to the long term survival. While Giacomelli and Veronesi[14] obtained a six year survival in 5 out of 27 patients operated on according to the Bucalossi and Margottini technique, other investigators do not feel that this operation greatly changes the percentage of survivals as compared to the one realized by the usual techniques of radical mastectomy; and (3) it is difficult to detect the existence of metastases in the internal mammary lymph nodes.

During the last few years repeated attempts have been made to determine the status of the internal mammary lymphatic chain by means of opacification of the in-

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ternal thoracic veins by injecting a contrast medium into the sternal bone marrow. It was hoped that because of the close relationship of the internal mammary lymph nodes to the internal mammary veins, changes in the latter, such as alteration of caliber, compression, displacement, etc., may help in establishing the size or configuration of the lymph nodes. Fischgold, *et al.*,[12] Ambrosi and Margiotta,[3] Zierhut,[36] Kink,[24] and Gross, *et al.*[15] have carried out investigations along these lines. The present study is based on a review of these investigations and on personal experience gained with transsternal phlebography performed in normal subjects, in patients suffering from cancer of the breast in different stages of evolution, and in patients who had undergone mastectomy and then developed regional or distant metastases.

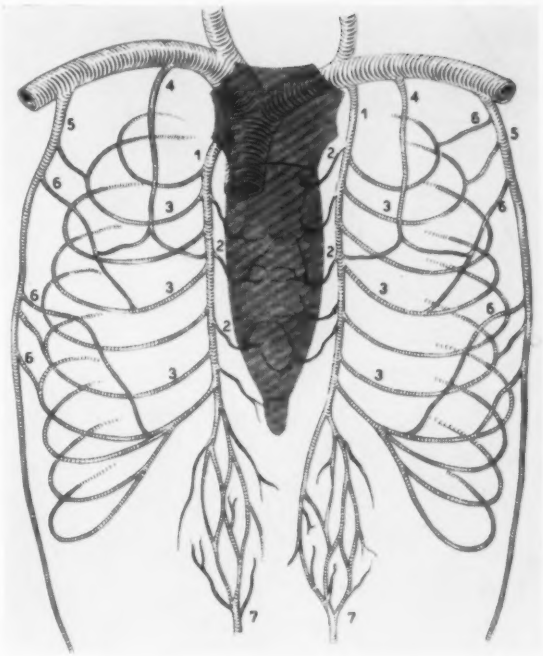


Fig. 1. Diagrammatic sketch showing the internal thoracic or mammary veins (1) which, according to Sobotta, are usually one to a side. They originate from the junction of the superior epigastric veins (7) with the musculophrenic veins. Above, they open into the brachiocephalic vein on the left side and into the descending vena cava on the right side. Of the affluent vessels of the internal mammary veins, the diagram shows: the sternal veins (2) originating from the periosteal networks situated on the two surfaces of the sternum and the first seven intercostal veins (3). The lateral thoracic veins are indicated by (4) and these frequently flow into the axillary vein; said veins appear to anastomose (Spalteholtz) with the costoaxillary veins and with the internal mammary veins. The costoaxillary veins (6) transport the blood of the median tract of the intercostal veins in the sixth to seventh upper intercostal spaces to the thoracoepigastric vein (5).

Anatomy of the Internal Mammary Veins

The internal thoracic vein or internal mammary vein, arising from the junction of the superior epigastric veins with the musculophrenic veins, often has two stems which unite at the level of the sternal triangular muscle (second to third rib). Above this point, it becomes single and courses at the inner side of the artery bearing the same name.

The vein runs behind the thoracic wall, crossing the costal cartilages and, along with the artery, lies on the pleural wall, strengthened by the thin endothoracic fascia. Beneath, the internal mammary vessels run along the anterior surface of the thoracic transverse muscle.

The vein does not always have a completely vertical path, but may be sinuous, with convexities sometimes pointing medially and at other times laterally. In such instances, the distance from the sternal border, which is usually 8–10 mm. at the level of the first intercostal space and 20 mm. at the sixth intercostal space, may vary.

The caliber of the vessel is usually from 3 to 5 mm. in diameter.

In its course, the internal mammary vein receives as affluents the first seven intercostal veins which lead to the conveniently directed valve outlet. Furthermore, it receives the perforating branches or perforating veins, satellites of the arteries. The perforating veins, which are large in the first and second intercostal spaces and slender in the others, contain valves and collect part of the blood from the breast. Other affluent branches are the sternal veins,

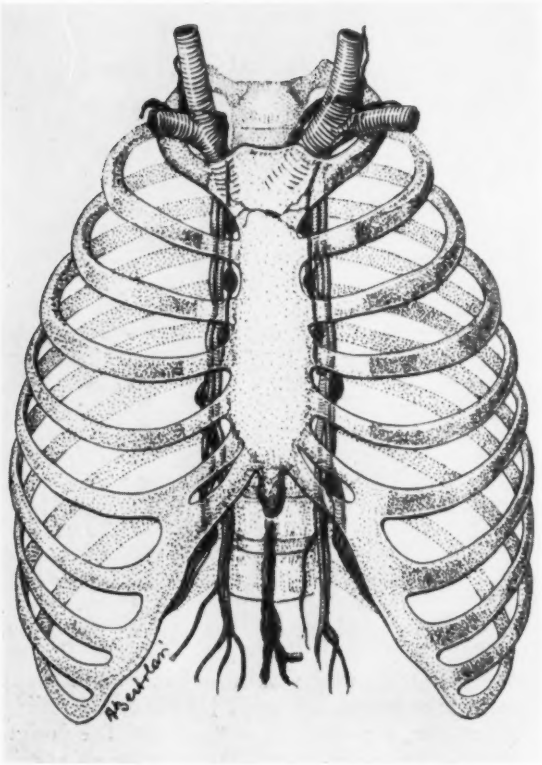
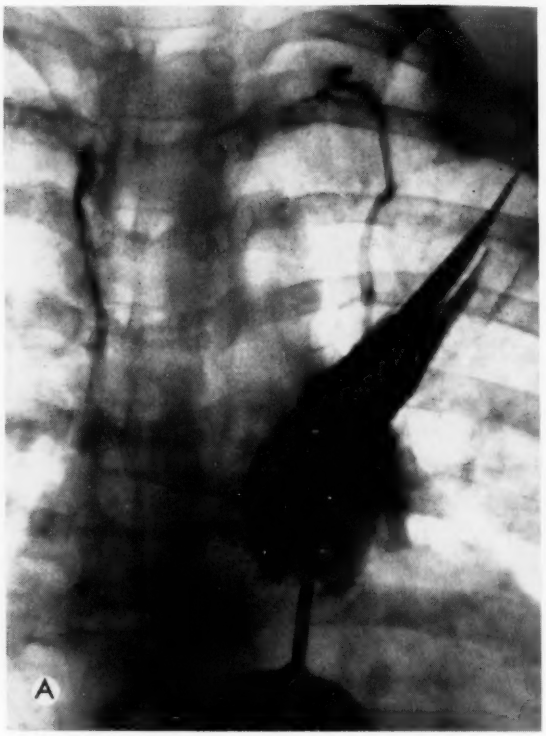


FIG. 2. Sketch of internal mammary lymphatic system.



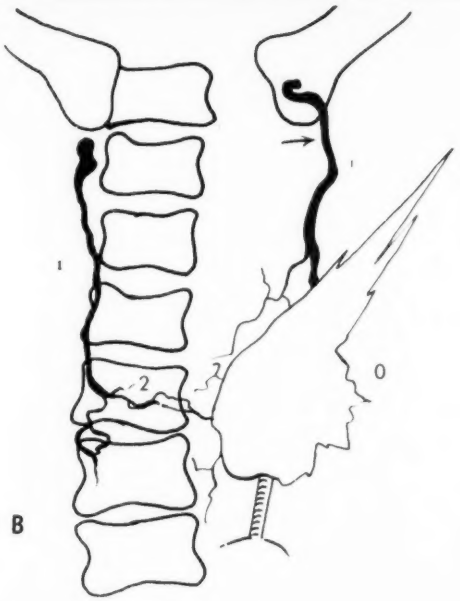


FIG. 3. (*A*) Transsternal phlebogram in a case of solid carcinoma of the lower inner quadrant of the left breast, with metastases to the homolateral axillary lymph nodes and to the homolateral internal mammary lymph nodes of the first three intercostal spaces. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced visualization of a wide curve of the left internal mammary vein (1), corresponding to the first and second intercostal spaces (arrow). Part of the contrast medium (0) has exuded between the fasciae of the pectoral muscle. The insufficient injection of the right internal mammary vein must be related to the poor passage of the contrast medium into the circulation and to the needle's eccentric position. The periosteal veins are easily distinguishable at the lower third of the sternum (2). (*B*) Line drawing of *A*. Pathologic pattern.

which are situated medially and originate from the periosteal networks of the two faces of the sternum. These networks put forth extensive and numerous anastomoses connecting with the mammary trunks on both sides.

Above, the internal mammary veins usually open into the brachiocephalic vein on the left side and into the union of the two innominate veins or the descending vena cava on the right side (Fig. 1).

The internal mammary veins form anastomoses with the azygos, through the intercostal veins, and with the external

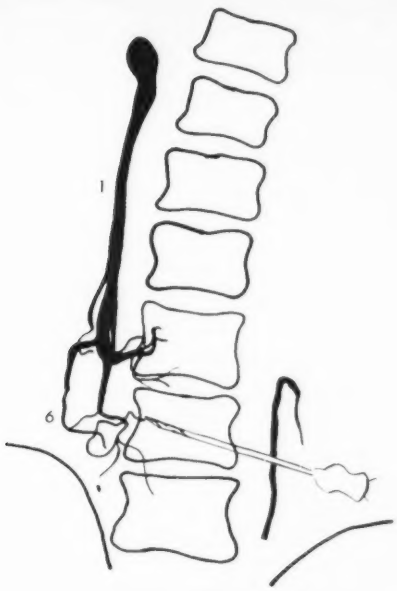


FIG. 4. (*A*) Transsternal phlebogram in a case of adenocarcinoma of the upper outer quadrant of the right breast with hyperplastic catarrhal state of the homolateral axillary lymph nodes. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced good injection of the right internal mammary vein (1) and of the superior epigastric veins (6). The absence of injection of the left internal mammary vein must be related to the needle's eccentric position. (*B*) Line drawing of *A*. Normal pattern.

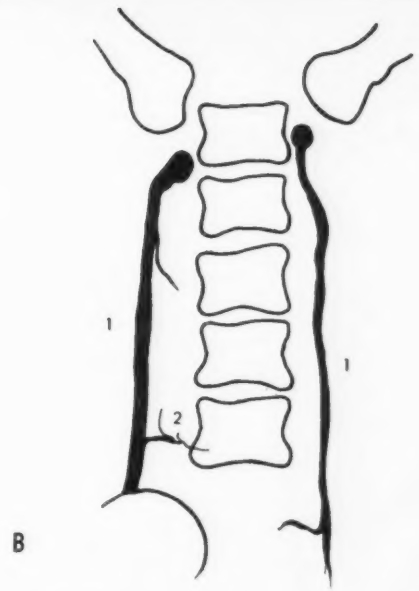


FIG. 5. (*A*) Transsternal phlebogram in a case of adenocarcinoma of the upper outer quadrant of the left breast with enlargement of the axillary lymph nodes. Injection of 20 cc. of 70 per cent diodrast into the sternal marrow resulted in good visualization of the two internal mammary veins (1). The caliber of the right internal mammary vein is slightly greater than that of the left. There is poor injection of the sternal periosteal veins (2). (*B*) Line drawing of *A*. Normal pattern.

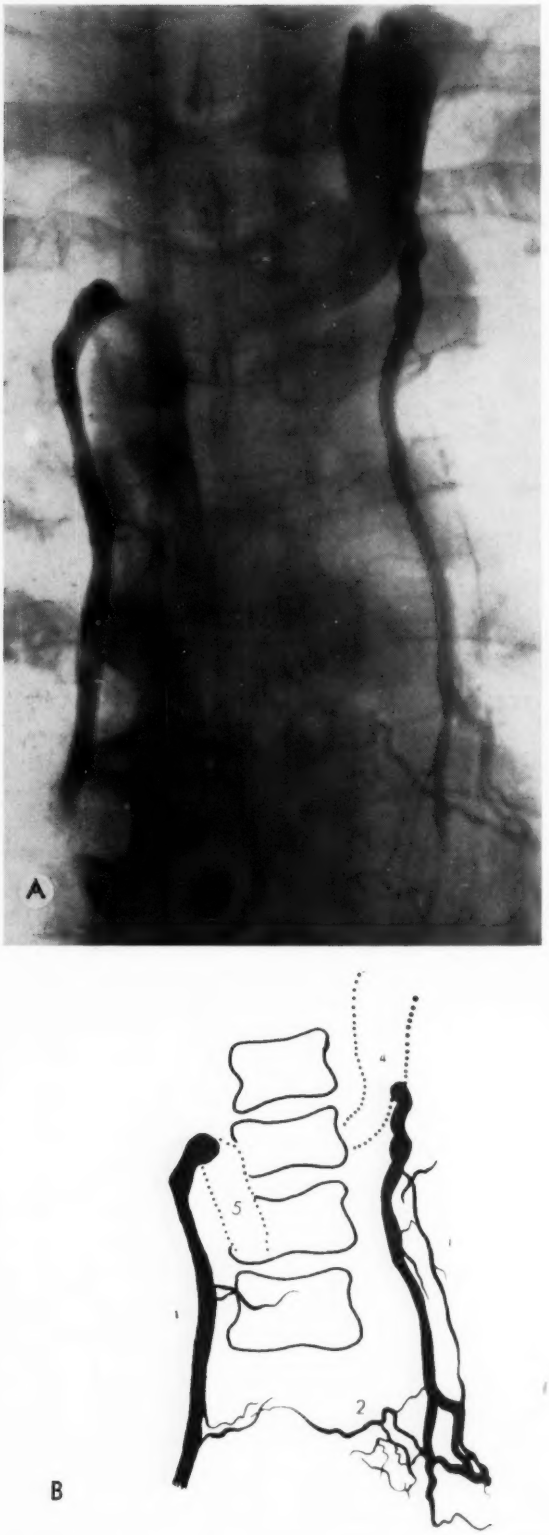


FIG. 6. (*A*) Transsternal phlebogram in a patient who one year previously underwent radical amputation of the right breast for solid carcinoma with involvement of the axillary lymph nodes and parietal resection of the left breast for papillomatosis in adenocarcinomatous degeneration of the ducts. Later a radical amputation of the left breast was performed. The patient was again hospitalized because of persistent pain in the nuchal region, back and right shoulder of a month's duration. Roentgenographic examination of the chest, cervical vertebrae and right shoulder revealed no signs of secondary localizations. Injections of 20 cc. of 70 per cent diodrast into the sternal marrow resulted in good visualization of the two internal mammary veins (1). The caliber of the right internal mammary vein is slightly greater than that of the left. There is good visualization of the periosteal network (2), of the brachiocephalic vein on the left side (4), and of the descending vena cava on the right side (5). (*B*) Line drawing of *A*. Normal pattern.

iliacs through the inferior epigastric veins.

By means of these communications, and of those which the internal mammary veins have with the abdominal subcutaneous veins through the cutaneous branches of the superior epigastric veins, another important anastomotic system between the two vena cava systems is formed.

ANATOMY OF THE INTERNAL MAMMARY LYMPHATIC SYSTEM

The internal mammary lymphatic system consists of a variable number of lymph nodes arranged along the two sides of the sternum behind the intercostal spaces and costal cartilages.

The internal mammary chain may comprise: (1) a single series of lymph nodes arranged on the lateral or medial side of the mammary vessels; (2) two series of lymph nodes, lateral and medial, with respect to the mammary vessels; or (3) a partial series of lymph nodes present only in a few intercostal spaces.

The number of parasternal lymph nodes varies greatly. They may total 6–10 according to Chiarugi,[8] 8–10 according to Bruni,[6] or 7 according to Sørensen[32] and Putti.[29]

According to Putti,[29] the frequency in the various intercostal spaces is as follows: first, 91 per cent; second, 89 per cent; third,

70 per cent; fourth, 46 per cent; fifth, 12 per cent; and sixth intercostal space, 10 per cent.

The lymph nodes of the first three intercostal spaces are situated medial to the homonomous vessels and are about 1 cm. distant from the sternal margin. In the other intercostal spaces they are lateral to the vessels at a distance of about 3 cm. from the edge of the sternum. The bifurcation lymph nodes, named thus because they are situated at the bifurcation of the internal mammary vessels (Fig. 2), are present in 23 per cent of the cases and are usually located at the level of the fifth intercostal space, between the origins of the musculophrenic artery and the cranial epigastric vessels.

A transverse branch connects the lymphatic mammary chains of both sides at the level of the first intercostal space.

According to Chiarugi[8] and other investigators, the efferent lymphatic vessels of the internal mammary lymph nodes join together in a single trunk, which on the left side empties into the thoracic duct at the junction between the internal jugular and subclavian veins and on the right side into the subclavian trunk.

This anatomic distribution explains the poor filtering power of the lymph nodes, as regards the wandering cancer cells and thus the greater danger of dissemination when the parasternal lymph nodes are affected as compared to involvement of the axillary lymph nodes (Wanke[35]).

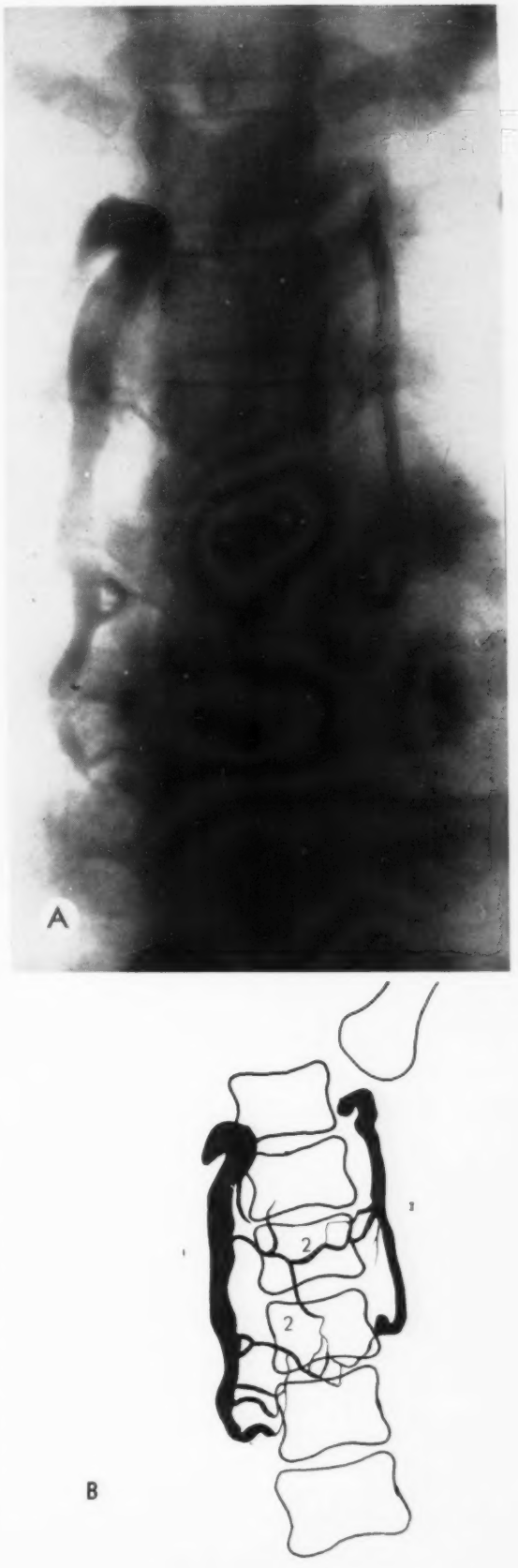


Fig. 7. (*A*) Transsternal phlebogram in a patient who in January, 1957, underwent radical amputation of the right breast for solid carcinoma with homolateral axillary lymph node metastases. The patient returned to the Institute for supplementary roentgen therapy. Roentgenographic examination of the thoracic area on re-admission revealed the existence of secondary pleuropulmonary localizations. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced good visualization of the two internal mammary veins (1). The right internal mammary vein has a caliber almost double that of the left. There is good injection of the sternal periosteal veins (2). (*B*) Line drawing of *A*. Normal pattern.

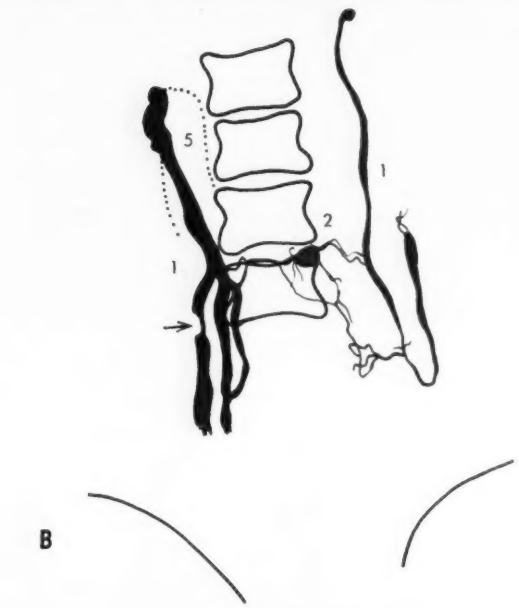


FIG. 8. (*A*) Transsternal phlebogram in a case of solid carcinoma of the upper inner quadrant of the right breast, with enlargement of the homolateral axillary lymph nodes. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced a marked visualization of the right internal mammary vein which is of the double type, the lateral stem showing an indentation just below the union (arrow). The sternal periosteal veins (2) and the descending vena cava (5) are well visualized. (*B*) Line drawing of *A*. Doubtful pattern.

TECHNIQUE

The most suitable technique for opacification of the internal mammary veins is based on the injection of the contrast medium into the bone marrow of the sternum. This technique, proposed by Fischgold *et al.*,[12] and Ambrosi and Margiotta,[3] was later adopted by Zierhut,[36] Kink,[24] and by Gross *et al.*[15] According to Süsse and Aurig,[34] opacification of the internal mammary veins can be obtained easier when the puncture is made in the sternal extremity of a rib and the needle is inserted in a forward oblique direction.

Our technique is as follows: The patient, after fasting for twelve hours, is placed on an ordinary roentgenographic table, to which a seriographic cassette for the rapid exposure of five roentgenograms has been applied. Before examination, the usual tests for allergic sensitivity to iodine (intradermal and ophthalmic tests) are performed. Local anesthesia is used with 1 per cent isocaine, after which the sternal puncture cannular needle is inserted in the lower third of the sternum. The puncture is made in the midline, obliquely to the osseous plane; then, to ensure that the point of the needle has penetrated into the bone marrow, an aspiration is done, by using a syringe connected to the needle. The contrast medium, usually 20 cc. of 70 per cent aqueous diodrast solution, is injected by normal manual pressure and the roentgenograms are exposed starting halfway through the injection and at intervals of about 3 seconds (200 ma., 76–80 kv., 1/10 sec., 100 cm. cassette-focus distance). At the end of the injection, the needle is withdrawn and after disinfection with alcoholic iodine solution, an elastoplast dressing is applied.

When the examination has been correctly performed, the patient will develop a fleeting sense of warmth in the face and neck and a slight pain locally, persisting for about two hours. Occasionally, some difficulty is encountered in introducing the needle, due to particular thickness of the compact osseous tissue. In such instances, it is advisable to use stronger needles, of

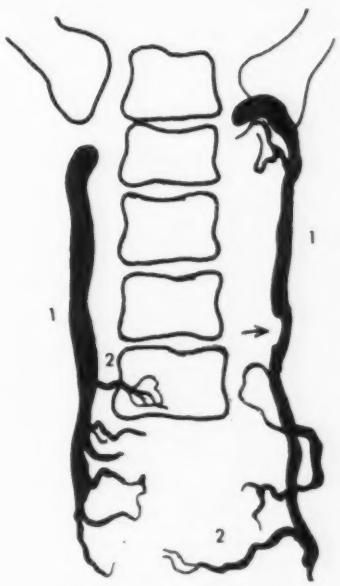


Fig. 9. Transsternal phlebogram in a case of intralobular intraductal adenocarcinoma of the upper outer quadrant of the left breast with metastases to one of the 6 axillary lymph nodes examined and to one internal mammary lymph node (only one was found in the material sent to the Anatomopathologic Department). Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow resulted in good injection of the two internal mammary veins (1) with the characteristic shepherd's crook appearance on the left side where the internal mammary vein opens into the brachiocephalic vein. There is good visualization of the periosteal veins (2). In the middle third of the left internal mammary vein there is an indentation due to pressure by an enlarged metastatic lymph node at this site. (*B*) Line drawing of *A*. Pathologic pattern.

⟹→

more than 1 mm. in diameter. When the sternum is porous, the needle will not stay in position, and it may be necessary to repeat the puncture. The contrast medium will then flow, during the injection, through the orifices of the previous punctures into the soft presternal tissues. This causes sharp pain and the appearance of false opaque images on the roentgenograms, rendering a diagnosis more difficult. Fortunately, the subjective symptomatology regresses completely within twenty-four hours, because of the ready absorption of the water-soluble contrast medium.

All in all, the examination is easy to perform and, in our opinion, does not present any special risk. Unlike other authors (Zierhut[36]) we do not consider that pentothal narcosis is necessary, since local anesthesia makes it possible for the patient to bear the pain caused by the sternal puncture and the introduction of the contrast medium.

A very important technical detail is that the point of the needle fixed into the lower third of the sternum should be exactly in the midline. If the point is to the left or to the right of the midline, there will be greater filling of the left or of the right internal mammary vein respectively and thus an accurate evaluation of the anatomic conditions of the vessels will become impossible.

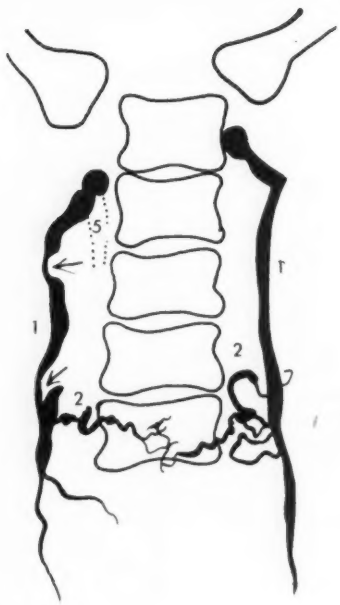


FIG. 10. (*A*) Transsternal phlebogram in a case of adenocarcinoma of the upper inner quadrant of the left breast with homolateral axillary lymph node metastases. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced good visualization of the internal mammary veins (1) and of the sternal periosteal network and the descending vena cava (5). The indentations of the right internal mammary vein (arrows) are due to hypertrophic costal cartilages. (*B*) Line drawing of *A*. Normal pattern.

RESULTS

Transsternal phlebography performed on 72 persons gave satisfactory diagnostic results in 60 cases; a demonstrative phlebogram was not obtained in the remaining patients, mainly for technical reasons.

1. In cases of porosity of the sternum and consequent repetition of the puncture there was partial reflux in the soft presternal tissues during injection of the contrast medium. This led to the appearance of false opaque images, which hindered interpretation of the phlebogram, and to inadequate visualization of the mammary veins (Fig. 3).

2. In some cases, although the point of the needle had satisfactorily penetrated into the bone marrow, there was inadequate visualization of the internal mammary veins. This was generally due to too slow injection of the contrast medium and its rapid passage into the general circulation, thus not reaching a sufficiently high concentration in the internal mammary veins.

3. The point of the needle must be exactly in the midline, as already stated; otherwise, only one of the two mammary veins will be injected, creating the impression of a pathologic condition (Fig. 4).

NORMAL ROENTGEN APPEARANCE

When the correct technique is used, the internal mammary veins are seen in the anteroposterior roentgenogram as two opaque linear images with twisting but distinct outlines and a parasternal course,

showing slight undulation because of the immediate contact with the costal cartilages. If the puncture is performed within the lower third of the sternal body, the vein is visualized in its entire length (Fig. 5).

The cranial portion of the vessel describes a curve resembling a shepherd's crook from above downward and from outward inward, before opening into the brachiocephalic vessel. In some cases we have had the opportunity to clearly visualize the brachiocephalic venous trunk on the left side and the descending vena cava on the right side (Fig. 6). This pattern is rare and depends on the rapidity with which the contrast medium travels to the two large veins and therein reaches a sufficient concentration.

In normal subjects the thickness of the internal mammary veins in the roentgenogram is of the order of a few millimeters. It is interesting to note that the right internal mammary vein has a larger diameter than the left in the majority of cases (Fig. 7). This finding, which is not mentioned in anatomic descriptions, has been observed by us in 45 patients. Also, the union of the two stems of the internal mammary vein into a single trunk has been observed to occur lower than reported by anatomists (Fig. 8). According to Testut and Jacob, the two stems of the internal mammary vein unite at the level of the first rib. We have observed in our cases union at the fourth rib in 10 instances, and at the third rib in 7 instances.

The first roentgenograms distinctly reveal the periosteal sternal veins. They appear as small branches with a serpentine course, varying in diameter from case to case, and running from the midline towards the right and left internal mammary veins. In some cases, these affluent vessels have a larger diameter and unite, the mammary veins of the two sides thus crossing the sternum.

PATHOLOGIC ROENTGEN FINDINGS

The close anatomic relationships between the lymph nodes of the internal

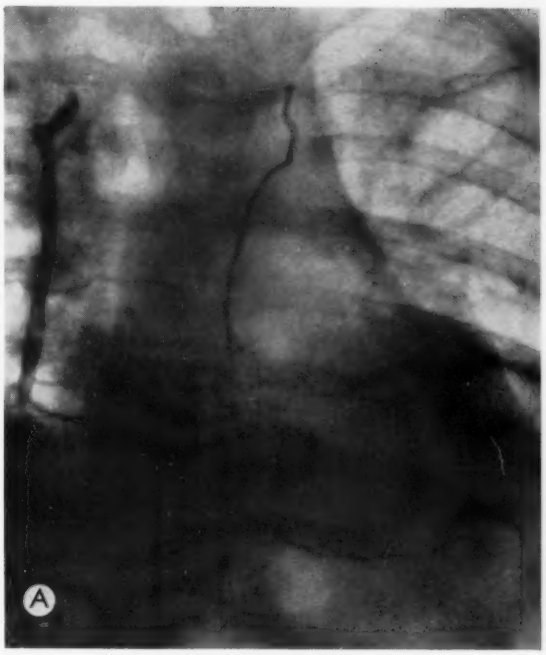
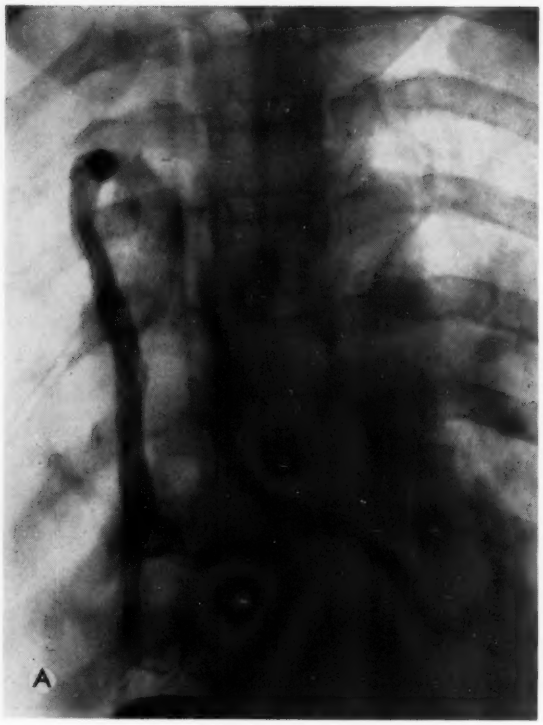


Fig. 11. (*A*) Transsternal phlebogram in a woman who in October, 1950, had radical amputation of the right breast for solid carcinoma, followed in June, 1956, by roentgen castration for skeletal metastases. The patient returned to the Institute for adrenalectomy. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced good visualization of the two internal mammary veins. The left internal mammary vein (1) shows a wide curve; there is good injection of the intercostal veins on this side (3). The right internal mammary vein has a large caliber and a regular course. (*B*) Line drawing of *A*. Pathologic pattern.



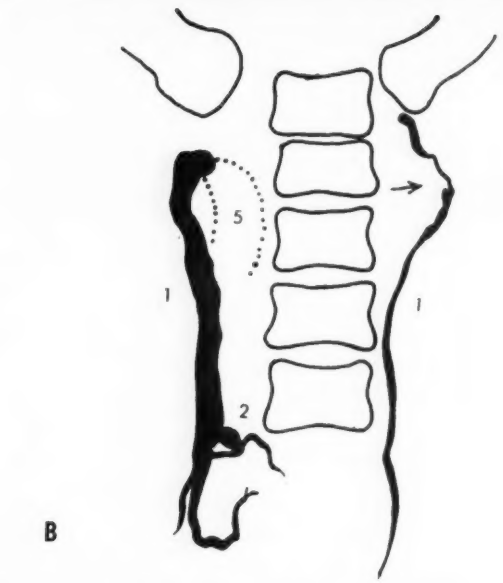


FIG. 12. (*A*) Transsternal phlebogram in a case of adenocarcinoma of the upper outer quadrant of the left breast with metastases to the homolateral axillary lymph nodes. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow resulted in poor injection of the left internal mammary vein (1), which shows sinusoid deviation and irregularity of the walls in its upper third (arrow). The right internal mammary vein has double the caliber of the left and a regular course. There is visualization of the descending vena cava (5). (*B*) Line drawing of *A*. Pathologic pattern.

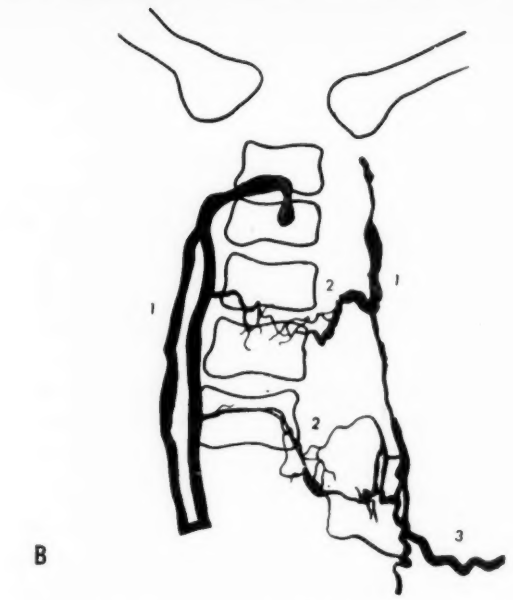
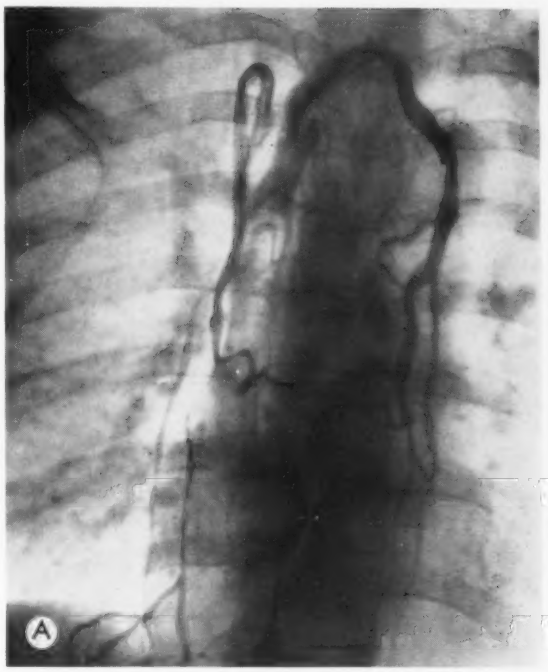


FIG. 13. (*A*) Transsternal phlebogram in a case of solid carcinoma of the left para-areolar region with metastases to the homolateral axillary lymph nodes. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced good visualization of the internal mammary veins (1). The left internal mammary vein shows an irregular caliber, particularly in the middle third and near its opening into the brachiocephalic vein. A retrograde injection of the intercostal veins (3) has taken place on this side. The right internal mammary vein is double almost up to its opening into the descending vena cava. There is good visualization of the periosteal circulation (2). (*B*) Line drawing of *A*. Pathologic pattern.



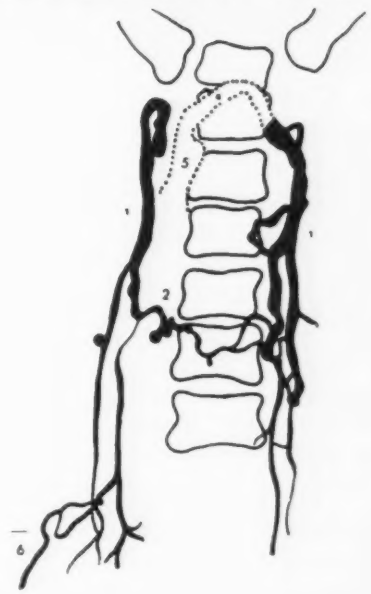


Fig. 14. (*A*) Transsternal phlebogram in a case of extensive ulcerated vegetating carcinoma of the right breast with hard fixed lymph nodes in the homolateral axilla. The patient was admitted to the Institute for adrenalectomy. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced good visualization, demonstrating reduction of the caliber of the caudal portion of the right internal mammary vein (1). This side also shows retrograde injection of the epigastric veins (upper) and of the musculophrenic veins (6). The transverse sternal anastomoses (2) appear obstructed. The left internal mammary vein is of greater caliber than the right and is double for about half of its course. The upper epigastric veins are visible on this side also. There is good injection of the brachiocephalic vein (4) on the left side, and of the descending vena cava (5) on the right side. (*B*) Line drawing of *A*. Pathologic pattern.

mammary chain and the homonomous veins may be utilized to evaluate the effect of enlarged lymph nodes on the venous wall in cases of involvement by a metastatic neoplastic process. The veins may be compressed and displaced, or may show an abnormal course on the roentgenograms. Thus, one may observe (1) indentations on the vessel wall with more or less evident filling defects; (2) irregularity in the course; and (3) reduction in caliber and complete block of the internal mammary veins.

1. *Indentations on the Vessel Wall.* Kink[24] has described these images, which are noted along the path of the veins, as "pelote" shaped, because of their notched appearance. In the case illustrated in Figure 9 an oval indentation was demonstrated in the middle third of the left internal mammary vein, and must be attributed to pressure from an enlarged metastatic lymph node (confirmed by biopsy). In other cases (Fig. 10) in which regular indentations are found at the level of the costal cartilages, the picture is not as clear, since hypertrophic cartilaginous rib ends may produce similar notchings.

2. *Irregularity in the Vessel's Course.* This is the pattern most commonly observed. The two internal mammary veins have a very tortuous path and, in some cases, show considerable deviation from the normal, pursuing curves with medial or lateral convexities. Since in normal roentgenologic anatomy every convexity is counterbalanced by a perfectly similar concavity, these sinusoid curves are of equal length, beginning from the point of origin of the internal mammary veins to their opening into the large venous trunks.

Thus, whenever an irregularity in the

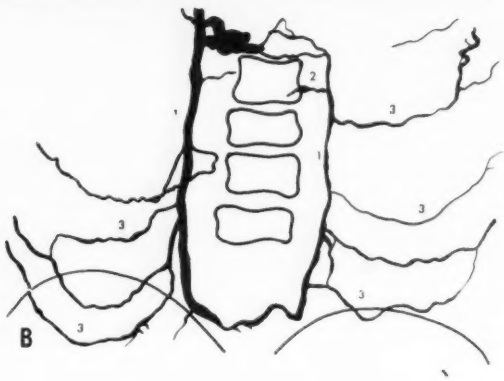


FIG. 15. (*A*) Transsternal phlebogram in a woman with skeletal metastases, who the year before had a left radical mastectomy for solid carcinoma which had extended to the homolateral axillary lymph nodes. Patient was re-admitted for oophorectomy and adrenalectomy. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow resulted in poor injection of the left internal mammary vein (1) which is obstructed near its opening into the brachiocephalic vein. There is bilateral retrograde injection of the intercostal veins (3). The right mammary vein shows multiple indentations due to the costal cartilages. (*B*) Line drawing of *A*. Pathologic pattern.

path of the vessel associated with a reduction in caliber is found on only one side (Fig. 11), the alteration may be linked to displacement and compression caused by an enlarged metastatic lymph node at this site. In some instances, an irregular outline of the notched venous wall may also be noted, due most probably to contiguous invasion by the neoplastic process.

3. *Reduction in Caliber and Complete Block of the Veins.* These findings occur less frequently but, if present, they permit an easier and more accurate diagnosis.

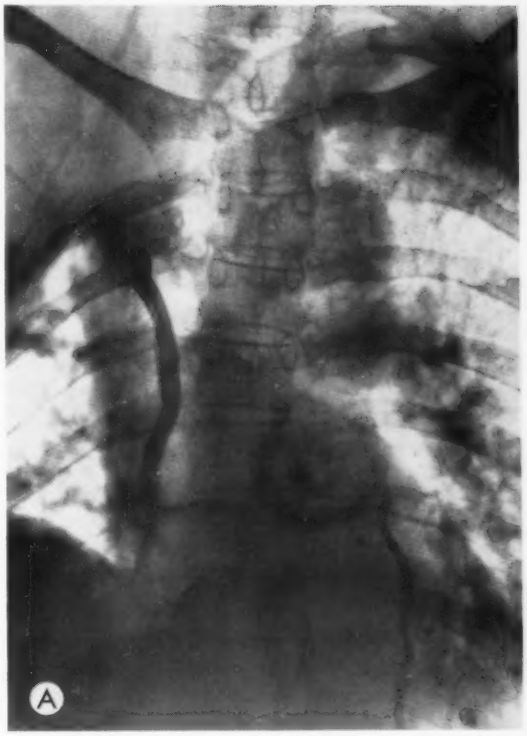
Uniform narrowing of the vessel's lumen must be distinguished from complete block. When narrowing affects the left internal mammary vein, the difference in caliber which already exists under normal conditions is greatly enhanced so that the right mammary vein will appear twice or thrice as large as the left (Fig. 12). This is due partly to the increased flow of blood to the right vein and partly to the already mentioned anatomic difference in caliber. Complete block is observed in some cases; it then becomes necessary to distinguish whether the block is at the level of the vein's opening into the brachiocephalic trunk or in the middle or lower third of the vessel. In the first instance, stasis occurs below the obstacle and there follows retrograde injection of the collateral pathways, *i.e.*, the intercostal veins (Fig. 13, 14 and 15), the upper epigastric veins and the musculophrenic veins (Fig. 14), the valves of which become insufficient. In the second instance, when the block is in the middle or lower third of the internal mammary vein, the collateral pathways will not be injected and only an increase in the caliber of the stump of the vein will be observed (Fig. 16).

CONCLUSIONS

Transsternal phlebography for visualization of the internal mammary veins was performed during the period of one year in 72 persons without observing any ill effects.

Unlike other authors, we do not believe that small and symmetric indentations along the path of the internal mammary veins are the expression of a metastatic lymphadenopathy. Likewise, we do not consider the increased tortuosity of the vessels as due to multiple compressions by enlarged metastatic lymph nodes.

On the other hand, some diagnostic significance may be attributed to the isolated indentations (the so-called "pelote" images, or notchings), to the wide sinusoid deviations with reduction in the vessel's caliber, and to the complete block with stasis in all or part of the tributary venous system (in-



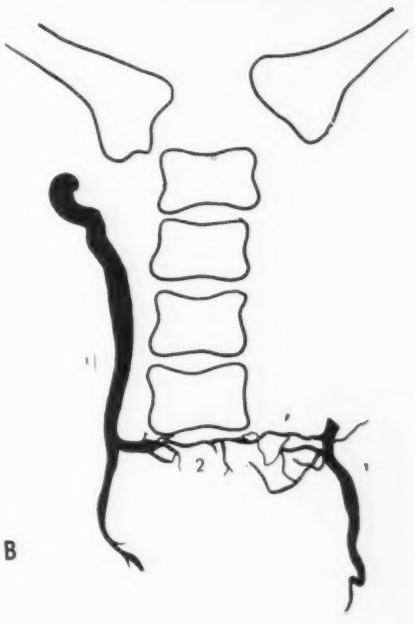


Fig. 16. (*A*) Transsternal phlebogram in a case of solid carcinoma of the upper outer quadrant of the left breast with enlargement of the homolateral axillary lymph nodes. Introduction of 20 cc. of 70 per cent diodrast into the sternal marrow produced good visualization of the left internal mammary vein in its distal third. There is retrograde injection of an intercostal vein on this side (3). The right internal mammary vein is of normal caliber and has a normal course (1). There is good visualization of the periosteal veins (2). (*B*) Line drawing of *A*. Pathologic pattern.

tercostal, upper epigastric and musculophrenic veins).

Single lymph node metastases may be suspected if they are at least the size of a pea. However, a definite roentgen diagnosis is possible only in the case of lymph node groups of a larger size. In this regard, transsternal phlebography of the internal mammary veins, by supplying information concerning the route of lymphatic flow not accessible to palpation and other methods of examination, may become a supplementary method in the management of patients afflicted with cancer of the breast. In particular, it may serve to determine whether or not pre- and postoperative irradiation should be extended to the retrosternal area.

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REFERENCES

1. Abrao, A., and da Silva Neto, J. B. Estudo anatômico de cadeia ganglionar mamária interna em 100 casos. *Rev. paulista med.*, 1954, *45*, 317–326.
2. Ackerman, L. V., and del Regato, J. A. Cancer: Diagnosis, Treatment, and Prognosis. Second edition. C. V. Mosby Company, St. Louis, 1954.
3. Ambrosi, G., and Margiotta, F. Flebografia mediante iniezione di sostanza opaca nello sterno, nota preventiva. *Minerva chir.*, 1952, *7*, 673–675.
4. Andreassen, M., Dahl-Iversen, E., and Sørensen, B. Glandular metastases in carcinoma of breast; results of more radical operation. *Lancet*, 1954, *1*, 176–178.
5. Berri, N. Operazione radicale per cancro della mammella con asportazione dei linfonodi mammari interni (metodo personale). *Minerva chir.*, 1952, *7*, 507–513.
6. Bruni, A. C. Compendio di anatomia descrittiva umana. Editor., F. Vallardi, Milano, 1945.
7. Ceelen, W. Die pathologisch-anatomischen Grundlagen des Mamma-karzinoms; besonders

im Hinblick auf die Strahlenbehandlung. *Strahlentherapie*, 1952, *87*, 7–33.

8. CHIARUGI, G. Anatomia umana. Vol. II. Editor, S. E. L., 1954.
9. CONFORTI, P., VERGA, V., and ZANNINI, G. La flebografia transdiploica. *Ann. ital. chir.*, 1952, *8*, 553–561.
10. DIOGUARDI, N. La flebografia transmedullo ossea. *Ann. ital. chir.*, 1952, *29*, 726–729.
11. FISCHGOLD, H., CLEMENT, J. C., TALAIRACH, J., and ECOIFFIER, J. Opacification des systèmes veineux rachidiens et craniens par voie osseuse. *Presse méd.*, 1952, *60*, 599–601.
12. FISCHGOLD, H., REBOUL, H., PIEQUET, J., and ECOIFFIER, J. Phlébographie mammaire par voie sternale. *J. de radiol. et d'électrol.*, 1952, *33*, 38.
13. FISCHGOLD, H., DAVID, M., TALAIRACH, J., and BREGEAT, P. Direct opacifying injections into the venous system of head. *Acta radiol.*, 1952, *40*, 128–138.
14. GIACOMELLI, V., and VERONESI, U. I linfatici mammari interni come sede e via di diffusione metastatica nel cancro della mammella. *Tumori*, 1952, *38*, 375–393.
15. GROSS, L., and others. De l'utilité de la phlébographie des veines mamaires internes. *J. de radiol. et d'électrol.*, 1957, *38*, 773–776.
16. GUCCI, G. La legatura delle arterie mammarie interne nella terapia della insufficienza coronarica. Editor, Macri. Firenze, 1957.
17. GUILHEM, P., BAUX, R., and PAILLE, J. Phlébographie pelvienne par voie trans-osseuse ischiatique. *J. de radiol. et d'électrol.*, 1952, *33*, 311–314.
18. GVOZDANOVIČ, V., and OBERHOFER, B. Mediastinal phlebography; bilateral simultaneous injection technique. *Acta radiol.*, 1953, *40*, 395–407.
19. HANDLEY, R. S., and THACKRAY, A. C. Internal mammary lymph chain in carcinoma of breast; study of 50 cases. *Lancet*, 1949, *2*, 276–278.
20. HANDLEY, R. S., and THACKRAY, A. C. Invasion of internal mammary lymph nodes in carcinoma of breast. *Brit. M. J.*, 1954, *1*, 61–63.
21. HANDLEY, W. S. Parasternal invasion of thorax in breast cancer and its suppression by use of radium tubes as operative precaution. *Surg., Gynec. & Obst.*, 1927, *45*, 721–728.
22. HULTBORN, K. A., LARSSON, L. G., and RAGNHULT, I. Lymph drainage from breast to axillary and parasternal lymph nodes, studied with aid of colloidal Au 198. *Acta radiol.*, 1954, *43*, 52–64.
23. KAHR, E. Darstellung der Beckenvenen mittels transossärer Serienphlebographie. *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, 1953, *78*, 449–455.
24. KINK, F. Die transternale Phlebographie der Vena mammaria interna. *Radiol. clin.*, 1956, *25*, 301–305.
25. MARGOTTINI, M. Basi anatomopatologiche e cliniche nel trattamento chirurgico del cancro della mammella. *Atti. Soc. Ital. di Chir.*, 1955, *57*, 318–322.
26. MARGOTTINI, M., and BUCALOSSI, P. Le metastasi linfoghiandolari mammarie interne nel cancro della mammela. *Oncologia*, 1948, *23*, 70–82.
27. MARGOTTINI, M., and PUTTI, F. Colorazione preoperatoria dei linfatici della mammella. *Atti Soc. Ital. di Chir.*, 1954, *56*, 426–430.
28. MÖRL, F. Die Bedeutung des sternalen Lymphstranges für die Metastasierung des Mammacarcinoms. *Chirurg*, 1952, *23*, 298–300.
29. PUTTI, F. Ricerche anatomiche sui linfonodi mammari interni. *Chir. ital.*, 1953, *7*, 161–167.
30. SALOMONI, I. Considerazioni sul valore della metastasi sternale nel quadro evolutivo del carcinoma mammario. *Nuntius Radiologicus*, 1957, *23*, 210–227.
31. SOBOTTA, J. Atlante de anatomia descrittiva. Vol. III. Editor, S.E.S., 1955.
32. SØRENSEN, B. Recherches sur la localisation des ganglions lymphatiques parasternaux par rapport aux espaces intercostaux. *J. internat. chir.*, 1951, *11*, 501–509.
33. STIBBE, E. P. Internal mammary lymphatic glands. *J. Anat.*, 1918, *52*, 257–274.
34. SÜSSE, H. J., and AURIG, G. Das transossale Venogramm der Venae intercostales, der Vena azygos und der Vena thoracica interna. *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, 1954, *81*, 335–345.
35. WANKE, R. Aktuelle Probleme der Therapie des Mamma-Karzinoms. *Strahlentherapie*, 1954, *96*, 279–285.
36. ZIERHUT, E. Zur Röntgendiagnostik der Lymphabflusswege beim Mammakarzinom. *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, 1955, *83*, 702–705.

Vol. 83, No. 2

PULSATIONS IN THE PULMONARY ARTERIES AS OBSERVED WITH ROENTGENOSCOPIC IMAGE AMPLIFICATION*

OBSERVATIONS IN PATIENTS WITH ISOLATED PULMONARY VALVULAR STENOSIS

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THE clinical and roentgenologic findings in isolated pulmonary stenosis are now well known. Several references have been made to pulsations in the pulmonary arteries seen with conventional roentgenoscopy,[1–4,7,9,11] but the authors are not aware of reports in which specific roentgenoscopic observations using image amplification have been published. Because of improved visibility of vascular structures in the lung when image amplification is used, more accurate observations of pulsatile activity of pulmonary arteries is possible. In a previous publication[6] observations of pulsations in the pulmonary arteries seen with image amplification were reported in a series of normal subjects. This report is concerned with observations of pulsations in the pulmonary arteries of patients with isolated pulmonary valvular stenosis.

METHODS OF STUDY

During the past four years a systematic roentgenoscopic study of the pulmonary vascular structures using image amplification has been carried out on patients undergoing cardiac catheterization in the Cardiovascular Laboratory of the Emory University School of Medicine. To date 185 patients have been studied. Roentgenoscopic observations were made without knowledge of the patients' clinical or cardiac catheterization data. A routine posteroanterior roentgenogram of the chest was obtained following the roentgenoscopic examination (Fig. 1 and 2). From observations of the pulsations of the pulmonary arteries seen roentgenoscopically and the pulmonary vascular pattern seen on roentgenograms, a prediction of pulmonary blood flow and pulmonary artery pressure was made. The roentgenologic observations were then correlated with cardiac catheterization data. Of 185 patients, 20 have subsequently been proved to have isolated pulmonary valvular stenosis (Table III).

Pulsations in the pulmonary arteries were graded as follows: 0 = no visible pulsation; + = faint, but definite intrinsic pulsation; ++ = easily identified intrinsic pulsation intermediate between + and +++; +++ = marked increase in intrinsic pulsations definitely abnormal.

Particular note was made of the pulsations in the following locations (Table 1): (1) the main pulmonary artery segment of the left heart border; (2) the left pulmonary artery in the left hilus; (3) the peripheral pulmonary arteries in the basilar portions of the left lung; (4) the right descending pulmonary artery in the right hilus; and (5) the peripheral pulmonary arteries in the basilar portions of the right lung.

From the chest roentgenogram the size of the pulmonary artery in the left hilus and peripheral portions of both lungs was graded as follows: diminished (0), normal (+), slightly enlarged to moderately enlarged (++), and markedly enlarged (+++). The prominence of the main pulmonary artery segment of the left heart border was evaluated in a similar manner.

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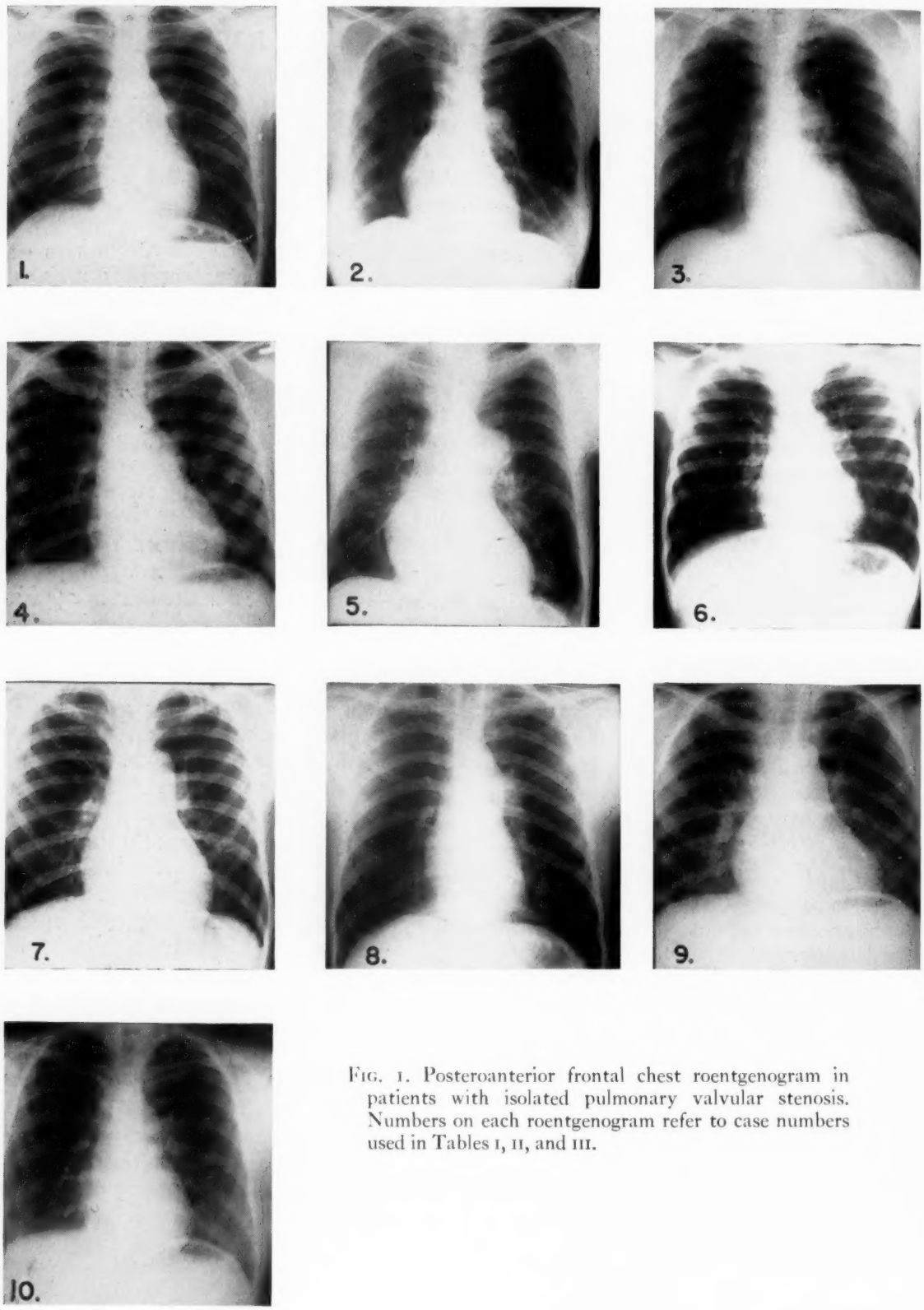

FIG. 1. Posteroanterior frontal chest roentgenogram in patients with isolated pulmonary valvular stenosis. Numbers on each roentgenogram refer to case numbers used in Tables I, II, and III.

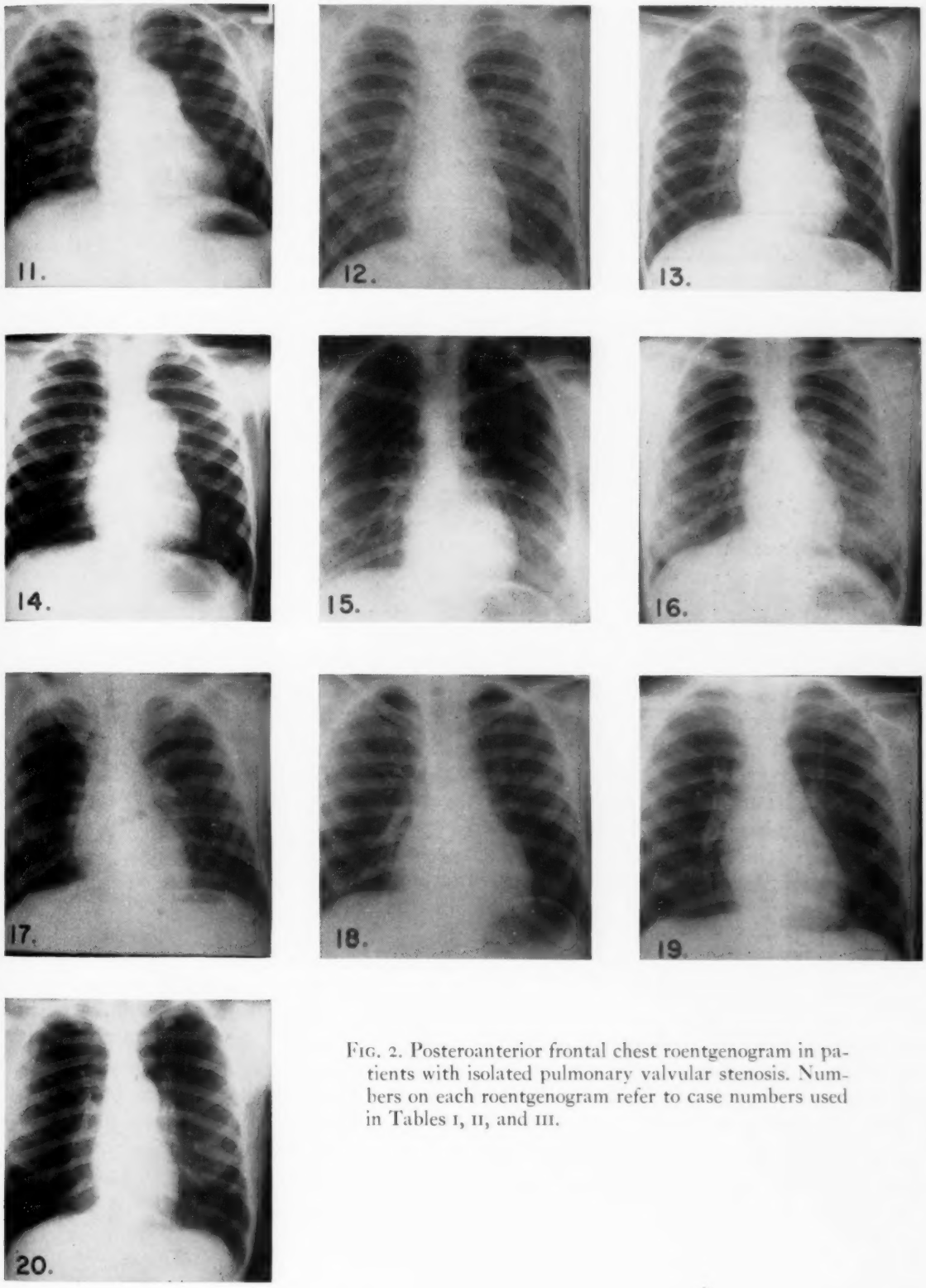

FIG. 2. Posteroanterior frontal chest roentgenogram in patients with isolated pulmonary valvular stenosis. Numbers on each roentgenogram refer to case numbers used in Tables I, II, and III.

TABLE I

ISOLATED PULMONARY STENOSIS
ROENTGENOSCOPY WITH IMAGE AMPLIFICATION

Case No.	Age	Sex	Main Pulmonary Artery	Left Pulmonary Artery	Left Basilar Branch	Right Descending Pulmonary Artery	Right Basilar Branch
1 (J.B.C.)	32	M	+++	+++	o	o	o
2 (M.E.)	45	F	+	+	o	o	o
3 (W.M.)	33	M	++	++	+	+	o
4 (L.B.)	11	F	+++	+++	++	+	o
5 (H.W.S.)	51	M	+	+	o	o	o
6 (E.P.)	5	F	+++	+++	o	o	o
7 (K.G.)	11	M	+++	+++	++	+	o
8 (E.K.B.)	17	M	++	++	o	o	o
9 (V.L.B.)	8	F	+++	+++	+	o	o
10 (G.A.D.)	11	F	+++	+++	+++	o	o
11 (L.M.)	3	F	+++	+++	o	o	o
12 (Q.D.)	11	M	+++	+++	+	o	o
13 (C.B.)	8	F	+++	+++	o	o	o
14 (C.C.)	5	F	+++	+++	o	o	o
15 (B.B.)	15	F	+	+	o	+	o
16 (P.S.)	18	F	+++	+++	++	o	o
17 (D.R.R.)	7	F	+++	+++	+	o	o
18 (N.M.D.)	8	F	+++	+++	+++	+	o
19 (R.A.J.)	5	F	+++	+++	+	o	o
20 (V.S.)	35	F	+++	+++	+	o	o

The size of the right descending pulmonary artery branch in the right hilus was measured and the greatest transverse diameter recorded. In normal adolescent and adult subjects, this measurement varies between 9–15 mm.; in children up to ten years of age the normal range is 5–10 mm. Over-all heart size was graded as normal (+), slightly enlarged to moderately enlarged (++), and markedly enlarged (+++).

As reported previously,[6] faint pulsations (+) in the descending branch of the right pulmonary artery are readily visible with roentgenoscopic image amplification in normal individuals. Pulsations in the left pulmonary artery in the left hilus may be equal to the right descending branch in amplitude (+), but in 40 per cent of normal subjects, the left hilar pulmonary arterial branch pulsation is slightly more prominent (++). Pulsations of the basilar arterial branches in the right lung base are not visible, whereas the pulsations at the left lung base are usually faintly visible (+).

Data for pulsations of the pulmonary arteries and roentgenographic findings in patients with pulmonary valvular stenosis are recorded in Tables I and II. Table III records pertinent data gained from cardiac catheterization.

RESULTS

From the data a distinct pattern of pulsations in the pulmonary arteries became evident in patients with pulmonary valvular stenosis. The main pulmonary segment of the left heart border and the left pulmonary artery in the left hilus showed definitely increased pulsations (+++) in 15 of the 20 patients, slightly increased pulsations (++) in 2 patients, and normal pulsations (+) in only 3 patients. Two of the latter patients had low cardiac indices (1.7 and 2.3 L./min./m.^{2}, respectively) and were in the older age group (forty-five

Table II

ISOLATED PULMONARY STENOSIS
ROENTGENOGRAPHIC FINDINGS

Case No.	Age	Sex	Heart Size	Main Pulmonary Artery	Left Pulmonary Artery	Left Basilar Branch	Right Descending Pulmonary Artery (mm.)	Right Basilar Branch	Pulmonary Veins
1 (J.B.C.)	32	M	+	++	+++	+	17	+	+
2 (M.E.)	45	F	++	+	+++	o	5	o	+
3 (W.M.)	33	M	++	++	+++	+	12	+	+
4 (L.B.)	11	F	++	++	+	+	12	+	+
5 (H.W.S.)	51	M	+++	+++	+++	o	14	o	+
6 (E.P.)	5	F	+	+++	++	+	10	+	+
7 (K.G.)	11	M	++	+++	++	+	10	+	+
8 (E.K.B.)	17	M	+	+++	+++	+	15	+	+
9 (V.L.B.)	8	F	++	+	++	+	12	+	+
10 (G.A.D.)	11	F	++	++	+	+	13	+	+
11 (L.M.)	3	F	+	+++	++	+	9	+	+
12 (Q.D.)	11	M	+	++	++	+	10	+	+
13 (C.B.)	8	F	++	+++	++	+	10	+	+
14 (C.C.)	5	F	++	++	++	+	10	+	+
15 (B.B.)	15	F	+	+	++	+	12	+	++
16 (P.S.)	18	F	+	+	++	+	12	+	+
17 (D.R.R.)	7	F	+	++	+++	+	12	+	+
18 (N.M.D.)	8	F	+	++	+	+	9	+	+
19 (R.A.J.)	5	F	+	+	++	+	11	+	+
20 (V.S.)	35	F	+	++	+++	+	13	+	+

years and fifty-one years, respectively).

In contrast to the left pulmonary artery, the right descending pulmonary artery branch showed intrinsic pulsations (+) in only 5 of 20 patients; the remaining 15 patients showed *no visible pulsations* of the right descending branch. Pulsations in the basilar branches of the pulmonary arteries were not observed in the right lung base, but varying degrees of pulsations were seen in the left lung base in 11 of 20 patients. In 16 of the 20 patients, pulsations of the left hilar pulmonary artery branch were considerably increased in amplitude over pulsations in the right descending pulmonary artery in the right hilus. Slight asymmetry in left and right hilar arterial pulsations is seen normally, the left pulmonary arterial branch being more prominent than the right,[5] but in patients having pulmonary valvular stenosis this asymmetry of pulsations becomes strikingly accentuated with diminished pulsations in the right hilus and increased pulsations in the left hilus. In only 2 of the 20 patients with isolated pulmonary valvular stenosis were the hilar and basilar pulsations normal (Case 3 and 15).

Roentgenographic signs of isolated valvular pulmonary stenosis have been well described and our patients follow the same roentgenographic patterns as previously published by others (Table II). The pulmonary vascular pattern is usually normal, but was decreased in 2 patients of the series (Case 2 and 5). The left pulmonary artery in the left hilus was enlarged to varying degrees in 18 of the 20 patients.

The transverse diameter of the right descending pulmonary artery branch was essentially normal in 18 of the 20 patients. Case 1 showed a slightly dilated right

TABLE III

ISOLATED PULMONARY STENOSIS
CARDIAC CATHETERIZATION DATA

Case No.	Age	Sex	Right Ventricle Pressure (mm. Hg)	Pulmonary Artery Pressure* (mm. Hg)	Right Ventricle-Pulmonary Artery Gradient (mm. Hg)	Cardiac Output (L./min.)	Cardiac Index (L./min./m.²)
1 (J.B.C.)	32	M	117/4	(7)		4.2	2.6
2 (M.E.)	45	F	120/6	12/6 (8)	108	2.7	1.7
3 (W.M.)	33	M	103/7	(9)		5.6	2.8
4 (L.B.)	11	F	67/5	20/9 (11)	47	4.7	3.4
5 (H.W.S.)	51	M	165/10	23/14 (17)	142	3.8	2.3
6 (E.P.)	5	F	90/?			2.6	4.1
7 (K.G.)	11	M	108/6	17/7 (11)	91	3.0	2.7
8 (E.K.B.)	17	M	115/3	12/5 (8)	103	5.7	3.1
9 (V.L.B.)	8	F	116/5	(9)		3.5	3.7
10 (G.A.D.)	11	F	69/5	15/8 (12)	57	4.1	3.0
11 (L.M.)	3	F	112/7	16/8 (11)	96	1.8	3.4
12 (Q.D.)	11	M	105/4	20/10 (12)	85	4.6	4.0
13 (C.B.)	8	F	168/8	(7)		2.8	2.9
14 (C.C.)	5	F	40/5	20/9 (15)	20	3.7	4.7
15 (B.B.)	15	F	50/5	22/9	28	5.0	3.1
16 (P.S.)	18	F	107/7	25/10 (15)	82	3.2	2.2
17 (D.R.R.)	7	F	47/5	20/9	27	4.3	4.0
18 (N.M.D.)	8	F	45/7	27/10 (17)	20	3.4	3.7
19 (R.A.J.)	5	F	49/6	16/7	33	3.2	3.6
20 (V.S.)	35	F	50/?†	25/?	25	—	—

* Numbers in parentheses refer to mean pressures.
† Pressures recorded preoperatively, at operating table.

descending pulmonary artery branch (17 mm.), which showed no visible pulsations. Case 2 showed a very small right descending branch (5 mm.). Normal measurements vary between 9–15 mm. for this branch in the adult.

Cardiac size in frontal projection was normal in 11 of the 20 patients; when cardiac enlargement was present, this tended to be only slight. Only 1 patient showed marked enlargement of the heart. The pulmonary venous shadows were essentially normal in this series of patients with only 1 patient (Case 15) showing slightly prominent pulmonary veins roentgenographically.

DISCUSSION

With conventional roentgenoscopic equipment, pulsatile activity of the pulmonary artery branches in the lung hili and in the lung periphery is inadequately observed because visual perception at ordinary roentgenoscopic light levels is at best poor. Thus in the past, roentgenoscopic observations of pulsations were confined to the main pulmonary artery segment of the left heart border. Pulsations in the smaller pulmonary arteries were observed only where they were greatly increased over normal. A diminution in pulsations could not be appreciated since routinely one could not see the normal pulsations which were present. Hence, Van Buchem[11] stated that in uncomplicated pulmonary stenosis no expansile hilar pulsations were observed. Healey *et al.*[7] reported 9 cases of pulmonary stenosis and described enlargement or hyperactivity of the main pulmonary artery without an associated enlargement or

hyperactivity of its hilar or intrapulmonary branches. Kjellberg *et al.*[9] stated that pulsations of the main pulmonary trunk were increased but pulsations at the hilus were faint or could not be detected on roentgenoscopy. Campbell[4] noted that pulsation may be seen extending into the left pulmonary artery branch and on occasion might suggest increased pulmonary blood flow. Blount *et al.*[1,2] observed that the right and left pulmonary artery branches showed relatively quiet or decreased pulsations preoperatively. Bruwer[3] noted an increase in left hilar pulsations in 8 per cent of his patients with pulmonary valvular stenosis.

The normal right descending pulmonary artery branch can rarely be observed to show an easily visualized pulsation unless roentgenoscopic image amplification is used. Decreased or absent pulsations, therefore, in the right descending pulmonary artery branch can be evaluated only if amplification techniques are used. Characteristically, pulsations in the right descending pulmonary artery branch are not observed in patients with pulmonary valvular stenosis, whereas the pulsations of the left pulmonary artery branch in the left hilus are markedly increased in this condition. Pulsations in the right descending pulmonary artery branch were graded as 1+ in only 5 of 20 patients. No pulsations were observed in the remaining 15 cases. Pulsations in the right basilar arterial branches are not usually visible in normal subjects or in patients having pulmonary valvular stenosis. In normal subjects faint pulsations in the left basilar pulmonary artery branches are usually observed. In patients with pulmonary valvular stenosis, these pulsations are variable; absent or accentuated pulsations may be seen.

OTHER CONDITIONS IN WHICH PULSATIONS SIMULATED PULMONARY STENOSIS

Patients with *patent ductus arteriosus* or *aortic pulmonary window* frequently show pulsations which simulate pulmonary stenosis. There are usually two distinguishing features, however, with patent ductus arteriosus: (a) the aortic arch is enlarged and shows a striking increase in amplitude of pulsation, and (b) the right descending pulmonary artery branch shows some intrinsic pulsation (+). In pulmonary stenosis the aorta is small and shows no unusual pulsations and there is usually an *absence* of pulsation of the right descending pulmonary artery branch.

Patients with atrial septal defect after operative correction of the defect will show pulsations in the pulmonary arterial tree which simulate those seen in patients with pulmonic stenosis. Preoperatively, these patients show increased pulsations (+++) in both left and right pulmonary artery branches; postoperatively, the pulsations of the right descending pulmonary artery branch return to normal (+), but the left hilar pulmonary artery branch remains hyperactive (+++), thus simulating pulmonic stenosis. Pulsations in the right descending pulmonary artery branch were present in patients after atrial septal defect closure, but usually absent in patients with pulmonic valvular stenosis.

We have seen one patient with an extensive arteriovenous malformation of the left lung who showed increased pulsations in the left hilus and base and normal pulsations in the right lung.

One patient with rheumatic heart disease and mitral insufficiency showed the pulsation pattern seen in patients with pulmonic stenosis.

One-third of patients having a left to right intracardiac shunt in association with pulmonary valvular stenosis showed only the pulsation pattern of isolated pulmonic stenosis. The remaining patients in this group showed a generalized increase in pulsations of all pulmonary artery branches characteristic of increased pulmonary flow. These patients will be presented in a separate future communication.

None of our patients having pulmonary infundibular stenosis have shown the unequal pulsations in the right and left hilar pulmonary arterial branches as described in isolated pulmonary valvular stenosis. All

of our patients with infundibular stenosis have had other associated septal defects. This group of patients will also be described in a separate future communication.

POSSIBLE FACTORS RESPONSIBILE FOR ASYMMETRIC PULSATIONS IN THE PULMONARY ARTERIES IN PATIENTS WITH PULMONARY VALVULAR STENOSIS

The causes for increased pulsations in the left pulmonary artery associated with decreased or absent pulsations in the right descending pulmonary artery branch in patients with pulmonary valvular stenosis are not known. Several factors might be considered.

1. *Pulmonary blood flow.* As far as we know there is no alteration of blood flow to either lung in pulmonary stenosis. It would seem unlikely that a differential blood flow exists between left and right lungs to explain the differential pulsations.

2. *Blood pressure* within right and left pulmonary arteries has not been significantly unequal in our cases to be of any importance.*

3. *Thinning and increased tension in main and left pulmonary artery walls.* Thinning may be an acquired factor related to turbulence of the blood flow beyond a stenotic valve. Keith and coworkers[8] mention that severe pulmonic stenosis in very young infants shows no poststenotic dilatation until they are a few months of age. Cavina[5] in 1915 produced partial pulmonic stenosis by ligature in rabbits and later found the distal pulmonary artery larger. By Laplace's law, tension in the wall of the dilated main and left pulmonary artery is much increased in direct proportion to the increase in vessel radius.

Congenital weakness in the pulmonary artery wall seems unlikely. Histologically the main and left pulmonary artery walls, though reduced significantly in thickness, show the normal arrangement of elastic fibers.[10]

4. *The degree of pressure gradient between the right ventricle and pulmonary artery* is not an important factor since there has been no correlation between the severity of stenosis and the type of pulsation.

5. *Anatomic relationship of the left pulmonary artery to the main pulmonary artery* may be of some significance. The left branch is a direct continuation of the main artery, whereas the right branch arises at a right angle from the main pulmonary artery. Also, that portion of the right pulmonary artery which is visualized in the right hilus is anatomically farther away from the main pulmonary artery than is the left branch. The effects of turbulence of blood flow beyond the stenotic valve would seem to be more likely transferred to the left hilar branch than to the right hilar branch because of distance and angle of origin of the right pulmonary artery. In normal subjects a slight asymmetry in pulsations of the right and left hilar branches is present, but never to the degree seen in patients with pulmonary valvular stenosis.

PULSATIONS WITHIN THE PULMONARY ARTERIES AFTER PULMONARY VALVULOTOMY

Roentgenoscopy after pulmonary valvulotomy has been performed on only 4 patients of our series and on 2 additional patients who were not examined preoperatively. Case 1 showed no change in the pulsations of the left pulmonary arterial branches, whereas the right descending branch increased in its pulsations after valvulotomy (absent pulsations preoperatively; slight pulsations (+) postoperatively). Case 8 continued to show no pulsa-

* In valvular pulmonic stenosis, the phasic pressure tracing from the right pulmonary artery is, as a rule, much distorted and narrowed; however, in our experience, the left pulmonary artery frequently tends to show a more normal phasic pressure curve with a measurable pulse pressure. In 6 cases, in which pressures in both right and left pulmonary arteries were obtained, less distortion and a significantly wider pulse pressure were noted in the left pulmonary artery in 4 instances. Further pressure measurements in both pulmonary arteries, using an intracardiac manometer attached to the catheter tip, will be needed to confirm this preliminary observation.

tions in the right hilus postoperatively, but showed an increase in pulsations postoperatively in the left hilus (++ preoperatively to +++ postoperatively). Case 6 showed no change in the increased pulsations of the left pulmonary arterial branches, but showed a striking increase in pulsations of the right descending pulmonary artery branch after valvulotomy (absent pulsations preoperatively to markedly increased (+++) postoperatively). In this case one would suspect a significant degree of pulmonary valvular insufficiency produced by the operative procedure. This impression, however, has not been confirmed as yet by postoperative cardiac catheterization. We have seen 3 other patients who had had surgery for pulmonary stenosis in association with a preoperatively undiagnosed ventricular septal defect. These patients showed also a striking increase in pulsations of the pulmonary artery branches in the postoperative period as a result of a rapidly increasing left to right shunt through the septal defect, no shunt having been present prior to the valvulotomy. Case 20 showed identical pulmonary artery pulsations preoperatively and postoperatively. The other 2 patients who were not studied preoperatively showed markedly increased (+++) pulsations in the left hilar branches and only slight (+) pulsations in the right descending pulmonary artery branch, similar to the postoperative findings in Case 1.

Though the above postoperative observations are very limited, the data suggest that one may expect a slight increase in the pulsatile activity of the right descending pulmonary artery branch after pulmonary valvulotomy, particularly if pulsations in this branch were absent preoperatively. Also one may expect little or no change in the hyperactive pulsations of the left pulmonary artery branch after valvulotomy. If a marked increase in pulsations of the right descending pulmonary branch develops after pulmonary valvulotomy, one should consider the possibility of pulmonary insufficiency or a previously missed septal defect with a significant post-valvulotomy left to right shunt.

SUMMARY AND CONCLUSIONS

The use of roentgenoscopic image amplification greatly improves one's ability to visualize intrinsic pulsations in the pulmonary arterial branches within the lungs.

In patients having isolated valvular pulmonary stenosis, a characteristic pattern of pulsation is present. The main and left pulmonary arteries reveal a marked increase in intrinsic pulsation, whereas a diminution or absence of pulsation of the right descending pulmonary artery branch in the right hilus is seen. These roentgenoscopic findings are important signs of isolated pulmonary valvular stenosis and should be added to the other well known clinical and roentgenographic signs. This differential pulsation between left and right hilar areas has not been observed in our patients with pulmonary infundibular stenosis. Roentgenographically, the heart may be normal in size or slightly enlarged, the main and left pulmonary arteries are dilated, and the peripheral pulmonary arterial branches and pulmonary veins are usually normal.

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REFERENCES

1. Blount, S. G., Jr., McCord, M. C., Komesu, S., and Lanier, R. R. Roentgen aspects of isolated valvular pulmonic stenosis. *Radiology*, 1954, *62*, 337–343.
2. Blount, S. G., Jr., van Elk, J., Balchum, O. J., and Swan, H. Valvular pulmonary stenosis with intact ventricular septum; clinical and physiologic response to open valvuloplasty. *Circulation*, 1957, *15*, 814–826.
3. Bruwer, A. J. Practical value of posteroanterior roentgenogram and roentgenoscopy in certain types of heart disease. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., 1956, *76*, 664–692.
4. Campbell, M. Simple pulmonary stenosis;

pulmonary valvular stenosis with closed ventricular septum. *Brit. Heart J.*, 1954, *16*, 273–300.

5. CAVINA, G. Stenosi sperimentale dell'arteria pulmonare. *Arch. per le sc. med.*, 1915, *39*, 6. Quoted by Greene *et al.*, *Am. J. Med.*, 1949, *6*, 24–40.
6. GAY, B. B., JR., Nornal pulsations in pulmonary vascular tree as seen with roentgenoscopic image amplification. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1959, *81*, 801–806.
7. HEALEY, R. F., DEXTER, L., ELKIN, M., and SOSMAN, M. C. Roengtenographic changes in pulmonic stenosis; report of 9 cases. AM. J. ROENTGENOL. & RAD. THERAPY, 1950, *63*, 813–821.
8. KEITH, J. D., ROWE, R. D., and VLAD, P. Heart Disease in Infancy and Childhood. Macmillan Company, New York, 1958, p. 367.
9. KJELLBERG, S. R., MANNHEIMER, E., RUDHE, U., and JONSSON, B. Diagnosis of Congenital Heart Disease: A Clinical and Technical Study by the Cardiologic Team of the Pediatric Clinic, Karolinska Sjukhuset, Stockholm. Year Book Publishers, Inc., Chicago, 1954.
10. SELZER, A., CARNES, W. H., NOBLE, C. A., JR., HIGGINS, W. H., JR., and HOLMES, R. O. Syndrome of pulmonary stenosis with patent foramen ovale. *Am. J. Med.*, 1949, *6*, 3–23.
11. VAN BUCHEM, F. S. P. Dilatation of pulmonary artery in pulmonary stenosis. *Circulation*, 1956, *13*, 719–724.

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FACTORS INFLUENCING IMAGE QUALITY IN CINEROENTGENOGRAPHY*

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GOOD image quality is a necessary prerequisite to effective cineroentgenography. However, in evaluating the detail of cineroentgenograms, one must appreciate the difference in the visual perception of a moving picture as compared to a still picture. Even the finest detail in individual cineframes does not equal that seen in a comparable full-sized roentgenogram, although definition of the image in motion projection may be considerably improved. Slight changes in density seen on single frames become much more readily perceived when these recordings are viewed in motion because the eye and brain are able to integrate the varying densities. The apparent discrepancy in image detail obtained with cine- and conventional roentgenography therefore becomes considerably less from a practical standpoint. Nevertheless, poor cine-image detail obviously reduces the effectiveness of motion roentgenography. This paper will discuss the factors which influence the quality of the cine-image obtained with currently available roentgenologic equipment and adaptations. These factors are listed in Table 1. It is not within the scope of this paper to compare the relative merits of the cine-equipment produced by different manufacturers.

TABLE I

FACTORS INFLUENCING CINE-IMAGE QUALITY

1. Image Tube Scintillation (brightness factor)
2. Image Tube Focus
3. Focal Spot Size and Magnification
4. Camera Focus
5. Vignetting Effect of Optical System
6. Choice of Cinefilms
7. Film Size (16–35 mm.)
8. Kilovoltage and Grids
9. Film Processing
10. Exposure Time

EQUIPMENT

Our clinical experience in cinefluorography is limited to the electron (electrostatic triode) type of image intensifiers. The equipment used at Indiana University Medical Center consists of a 5 in. Westinghouse tube with 16 mm. camera, a 5 in. Philips tube with 16 mm. camera, and an 8 in. Picker tube with 16 and 35 mm. cameras (Fig. 1, *A*, *B* and *C*). Roentgen-ray exposures on the Westinghouse and Picker machines are pulsed asynchronously with the film advance, and constant density is maintained by brightness stabilizing circuits. The Philips unit passes a constant potential roentgen-ray beam continuously into the image tube, and the film exposures are terminated by a 180° shutter on the camera. Film density is controlled by a variable voltmeter which measures the relative current across the image tube. The film exposure time depends either on the filming speed in frames per second or upon the duration of the pulsation of the roentgen-ray tube.

IMAGE TUBE SCINTILLATION

An important factor affecting image quality is scintillation. A certain number of information bearing photons must strike the input phosphor of the image tube in order to form a clear image which then may be amplified and recorded. If an insufficient number of photons strikes the input phosphor per unit of time, the amplified image lacks definition and appears grainy.*[6] When

* This effect is amplified by coarse grain film emulsions. The inter-relationship of scintillation and film grain needs further evaluation.

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From the Department of Radiology, Indiana University Medical Center, Indianapolis, Indiana. Presented at the Sixtieth Annual Meeting of the American Roentgen Ray Society, Cincinnati, Ohio, September 22–25, 1959.

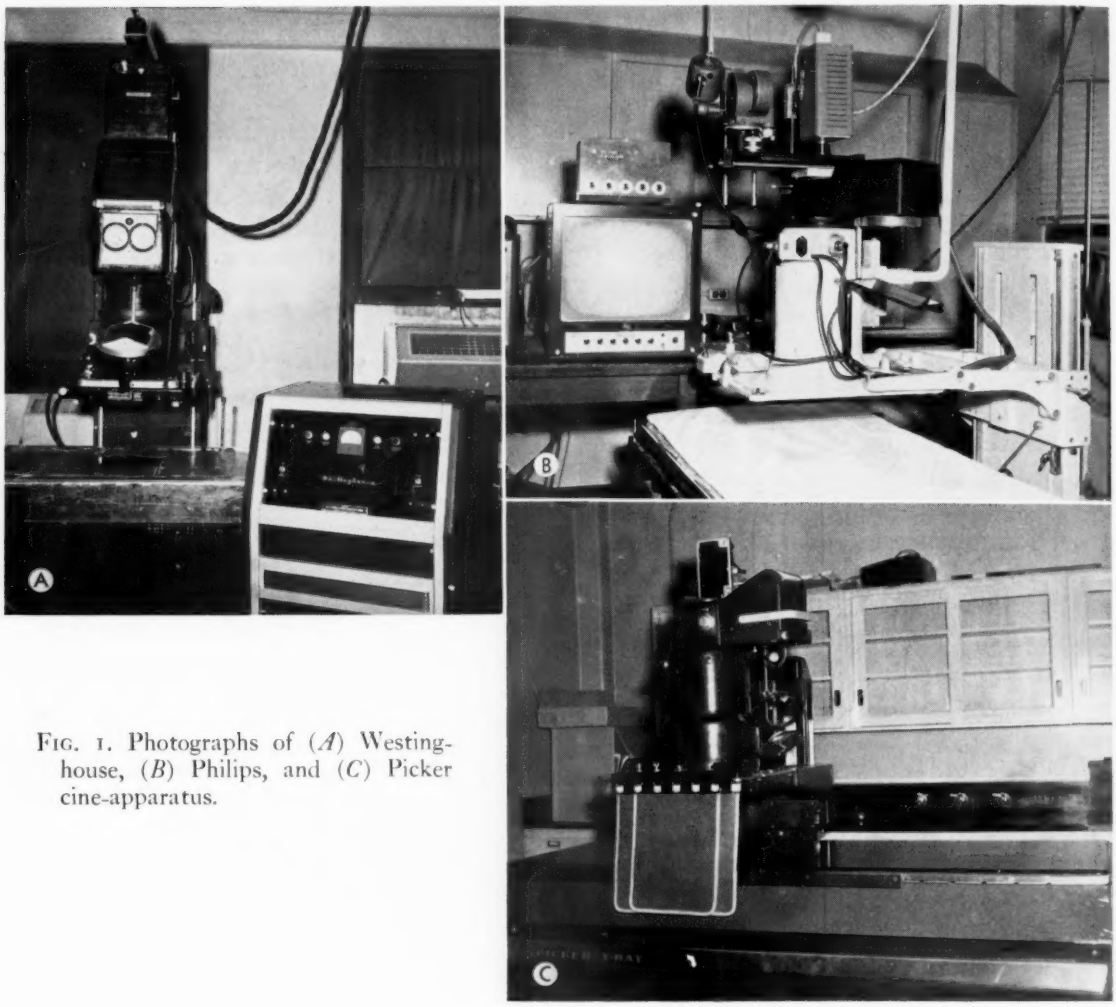

FIG. 1. Photographs of (*A*) Westinghouse, (*B*) Philips, and (*C*) Picker cine-apparatus.

viewed in motion, a coarse mottling effect is apparent in the image. In other words, there is a level of radiation below which an image of good quality will not be obtained. With image tubes of high brightness gain, it may be necessary to use a slower film or decrease the speed of the lens system in order to obtain an image of satisfactory quality.

In certain examinations, such as cystourethrography, moderate scintillation may have to be accepted in order to keep the gonadal radiation dose at a low level.[2] In other examinations, such as selective cinecardioangiography, where image detail is extremely important in order to diagnose the internal structure of the heart, it is necessary to operate above the scintillation level.[1]

IMAGE TUBE FOCUS

An image amplifier functions in a manner similar to the intensifying screen in conventional roentgenography. As the image is intensified, there is necessarily some loss in resolution as occurs in roentgenography when a screen image is compared to a non-screen image (Fig. 2,*A* and *B*). Obviously, the resolving power of a given image tube is inherent in its manufacture and beyond modification by the radiologist.

We have found the resolution of the image tubes of three manufacturers (Westinghouse, Philips, and Picker) to be similar. This was tested by viewing the resolution of different gauges of wire mesh on the periscopic mirror of the image tube or by photo-

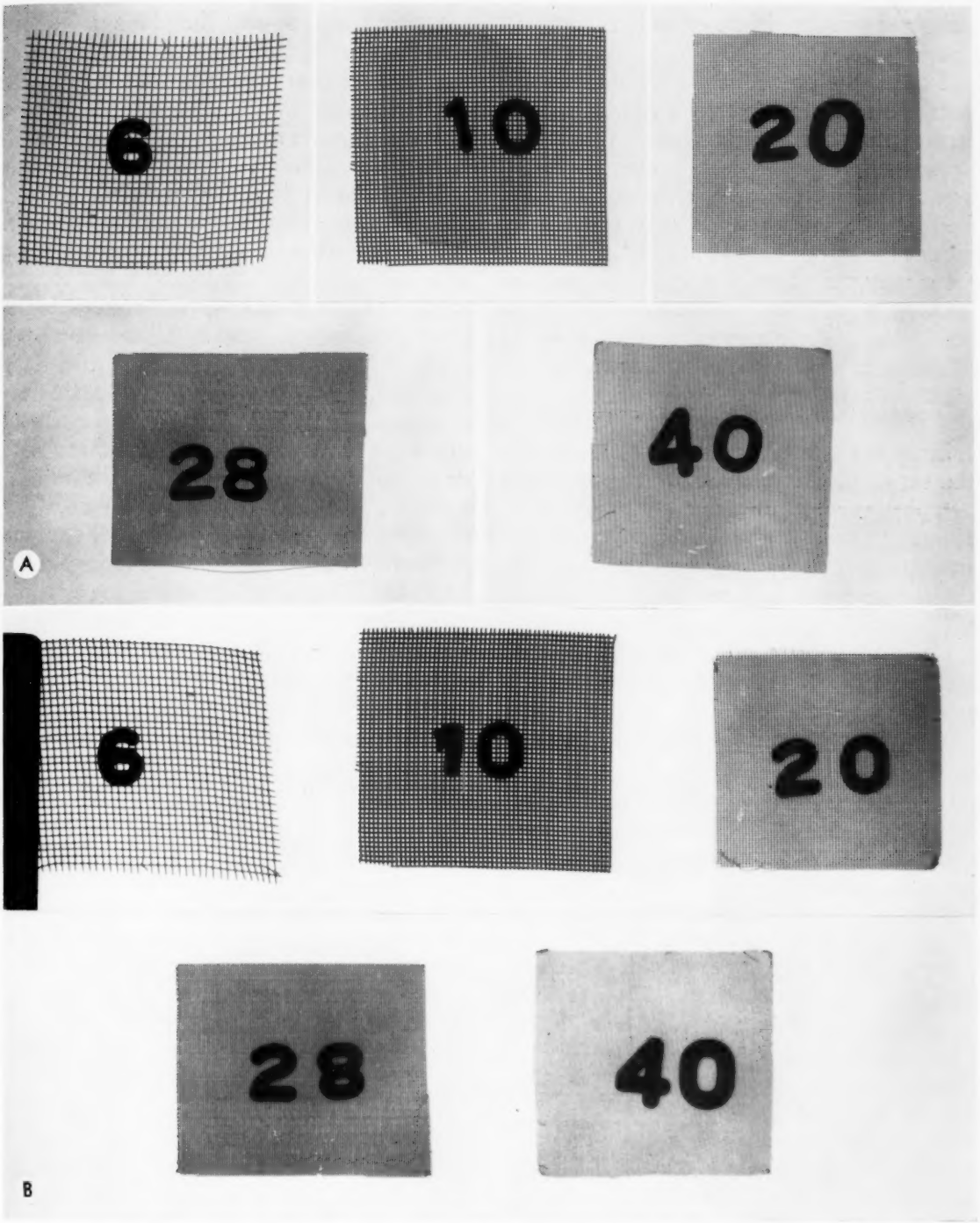

Fig. 2. Comparison of roentgenographic resolution of wire mesh samples varying from 6 to 40 line pairs per cm. in (*A*) non-screen exposure and (*B*) high speed screen exposure.

graphing the image on the output phosphor. By either method, each image tube resolved 10 line pairs per cm. (One line pair equals one black and one white line.) When the image is photographed on fine grain 35 mm. film, the resolution may reach an upper limit of 20 line pairs per cm.,[3] but for practical purposes a resolution of 10 line

pairs per cm. should be expected from any image tube.

The first correctable factor which may cause unsatisfactory image detail is poor electrostatic focus of the image tube. This is dependent upon the voltage applied across the electrodes. Even a slight variation of the optimum current will vastly reduce the image detail obtained. Since this focus may periodically change, it should be frequently adjusted while observing the resolution of #32 gauge wire screen showing 6 line pairs per cm. (standard screen wire).

FOCAL SPOT SIZE AND MAGNIFICATION

Since the fluoroscopic table height limits the target object distance in cineroentgenography, the magnification factor may contribute varying degrees of geometric unsharpness to the image. The use of a fractional millimeter focal spot will tend to offset this unsharpness to some extent as demonstrated in roentgenograms of the wire mesh taken with 0.3 and 2.0 mm. focal spots (Fig. 3).

Increasing the distance between the roentgen-ray tube and the plane of the object being roentgenographed will improve the resolution of the image as well as increase the size of the area which may be captured by the image tube. A greater increase in the target table top distance imposes a heat load on the anode which cannot be tolerated by the fractional focal spot. It is, therefore, necessary to accept a compromise between the target table top distance and the heat capacity of the roentgen-ray tube.

When roentgenographing a patient or phantom, it is difficult to perceive the gain in image sharpness of the fractional focal spot over the 1.0 mm. focal spot that is obvious on the roentgenograms of the wire mesh. It is probable that the secondary roentgen-ray scatter masks the slight improvement in detail. The tube rating of the fractional focal spot limits its use to children. There is also no gain in tube rating by using a focal spot size larger than 1.0 mm., since for cineroentgenography the tube capacity of focal spots 1.0 mm. or larger in size is governed by the total anode heat ca-

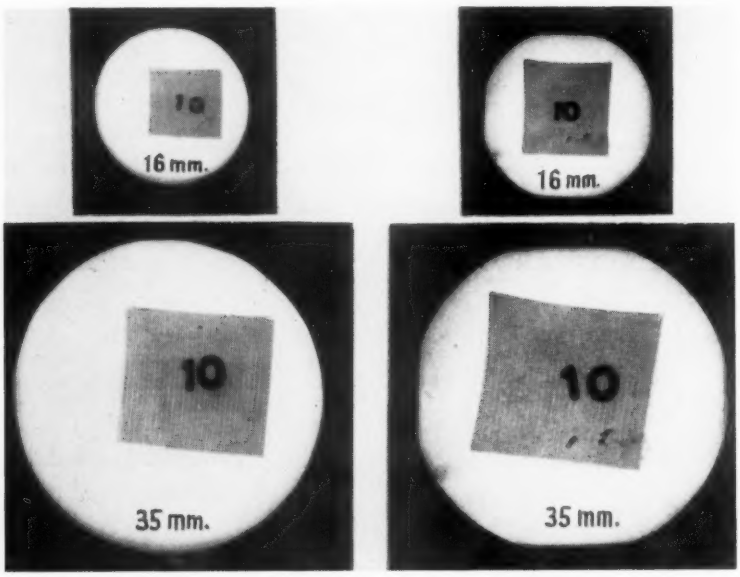

FIG. 3. Comparison of image resolution using fractional versus large size focal spot. These photographs of wire mesh (10 line pairs per cm.) were taken from the output phosphor of the image tube using the 0.3 mm. focal spot (left) and 2.0 mm. focal spot (right). There is slight loss of definition and slight magnification with the larger focal spot.

pacity, and not the anode surface temperature.[4]

Ideally, a fractional millimeter focal spot and a 1.0 mm. focal spot offers an optimum combination for cinefilming. This tube is currently only available at increased cost on special order from manufacturers.* Since the 1.0 mm. focal spot offers the best compromise between image quality and heat capacity, it should be included in the focal spot specifications in preference to either a larger or smaller size target.

CAMERA FOCUS

A frequent source of poor cine-image quality is a faulty optical system. Basically, the optical transmission of light from the image tube to the camera consists of two stages. The first stage lens is fixed in position over the image tube so that the output screen is within its focal length. This lens is not adjustable by the radiologist. The second stage lens is focused on the cinefilm and must be kept in sharp adjustment. A focusing test should be run by recording the image of the wire mesh on the cinefilm at a number of focus settings from infinity down to about four feet. These are examined on projection of the film to determine the focal setting which gives the sharpest image detail. Since it is possible for the focus of the camera lens to get out of adjustment through vibration or jarring of the camera, this focusing test should be repeated from time to time.

If the focusing test fails to produce a sharp image detail at any adjustment, it is probable that the first stage lens is defective. Professional assistance is then required to correct this, because this lens system is normally part of the tube or periscopic assembly. Obviously, the lens apertures should be wide enough to permit the fastest light transmission possible, and the focal lengths appropriate for conducting an image of such size as to fill the frame of the cinefilm being used.

* Machlett Corporation, Eureka Corporation, Dunlee Corporation, and Philips Corporation.

VIGNETTING EFFECT OF OPTICAL SYSTEM

Probably the greatest limiting factor in the optical system utilized for cineroentgenography is the so-called vignetting effect in the recorded film image. This occurs when there is light loss at the edges of the lens causing the film to receive less exposure in the peripheral zone than in the center. While this effect occurs to some extent in normal photography, it is more obvious on cinefilms which have a higher gamma gradation. Severe vignetting may result in the loss of as much as one-third of the film image at the periphery of the field. While it is virtually impossible to correct this effect entirely without seriously reducing lens speed, it is necessary to minimize it to a point where the entire output of the image tube is captured on the film. The density at the corner of the picture must be at least 50 per cent of the density at the center for satisfactory cine quality. Vignetting is more pronounced when wide aperture lenses are used (beyond f 1.5), when the mechanical separation of the first and second lens is unduly increased by the interposition of the viewing periscope and when high contrast film emulsions are employed.

The reduction of vignetting to tolerable limits usually requires the substitution of a lens system providing a different combination of focal lengths and diameters or one of better optical quality. The additional expenditure is a worthwhile investment. The lens combinations which have given us good image quality on 16 mm. high contrast (shellburst) cinefilms with a minimum of vignetting are given in Table II. Further reduction of vignetting may be accomplished by using films with less contrast and a wider exposure latitude.

CHOICE OF CINEFILM

Ideally, the proper cineroentgenographic film should have high speed, excellent contrast, and fine grain. The faster the film emulsion, the less the radiation dose administered to the patient. Theoretically a film of very

TABLE II

LENS COMBINATIONS FOR 16 MM. CINEROENTGENOGRAPHIC EQUIPMENT

Specification of Lens	Westinghouse		Philips		Picker	
	first stage	second stage	first stage	second stage	first stage	second stage
f. no.	1.1	1.0	2.0	1.0	1.0	0.95
Focal length (mm.)	100	37	75	37	50	25

high speed would seem to be most desirable. In actual practice the choice of film speed will depend on brightness gain of the image tube and the speed of the lens system. When an image tube with a brightness gain of 1,000 or more is combined with a fast camera lens system, the use of fast film emulsions may necessitate a decrease in radiation exposure rate to a level below that which will give an image of satisfactory quality.

Contrast is the difference in density of various portions of the film. A conventional roentgenogram has excellent contrast, and a cinefilm with similar contrast is desirable. It must be remembered that the latitude of a film is inversely proportional to the contrast so that, when using high contrast film, there is a narrow range of exposure for good image quality. If one is using a lens system which has marked vignetting, a film of high contrast may be objectionable.

Films of high contrast emphasize the difference between image density at the center and periphery of the field. A film emulsion of lower contrast permits the recording of adequate density at the periphery without grossly overexposing the center of the field.

The 5 to 8 in. image is reduced to a few millimeters in size on the film. When the film is projected, the film grain is magnified and may be objectionable. The larger the grain, the poorer the detail. Since the image to grain ratio is greater for 35 mm. film, a larger grain size is acceptable than with 16 mm. film.

In every instance it is necessary to employ a film which is a good compromise between speed, contrast and grain size. Table III compares the characteristics of a number of films tested. Most of our clinical experience has been with linagraph shellburst film. This emulsion has excellent contrast, moderate speed and moderate grain size. For 35 mm. photography a faster film with larger grain, such as Cine-Flure or Tri-X Reversal might be chosen. It should be again emphasized, however, that the choice of film will depend upon the characteristics of each individual installation.

FILM SIZE (16 AND 35 MM.)

Neither 16 mm. nor 35 mm. film is superior as a recording medium for cineroentgenography as each has definite advantages. The area of a 16 mm. cineframe is 78.5 $mm.^2$, while the area of a 35 mm. frame is 315 $mm.^2$, or a ratio of 1:4. Since the image

TABLE III

FILM EMULSION CHARACTERISTICS FOR CINEFLUOROGRAPHY

Film Type	Speed	Grain	Contrast
1. Linagraph Shell-burst	100	good	excellent
2. Linagraph Ortho	100	fair	good
3. Plus-X Negative	100	excellent	fair
4. Plus-X Reversal	100	excellent	fair
5. Cine-Flure	180	poor	excellent
6. Tri-X Negative	260	poor	fair
7. Tri-X Reversal	260	poor	good
8. DuPont 930	80	excellent	fair
9. DuPont 931-A	150	fair	fair
10. DuPont 936-A	130	excellent	fair
11. DuPont 928-A	160	fair	poor
12. Gevaert Scopix	400	poor	excellent
13. Ilford Hyper Pan	260	fair	poor
14. Ilford FP-3	150	fair	fair
15. Ansco Super Hypan	150	fair	fair
16. Fine Grain Positive			
17. Panatomic-X			

to grain size ratio is greater with 35 mm. film as compared to 16 mm. film, image resolution on 35 mm. film is theoretically better. Watson and Weinberg[7] found that the image resolution was improved from 11.0 line pairs per cm. to 14.0 line pairs per cm. when changing from 16 mm. to 35 mm. film. This can be demonstrated by photographing the image of the same wire mesh (20 line pairs per cm.) from the output phosphor on a film area 10 mm. (16 mm. movie frame) as compared to one 20 mm. in diameter (35 mm. movie frame). The wire mesh barely visible on the 35 mm. film is not visible on the 16 mm. film (Fig. 4). This improvement in image resolution is difficult to perceive on the projected image size used in clinical practice, however.

The dose rate to the patient is increased 2 to 4 times when one changes from 16 mm. to 35 mm. film size.* It is thus possible to utilize a slower, finer grain, 16 mm. film at the same or less radiation dose to the patient than when recording on 35 mm. film.

All handling problems are considerably less with 16 mm. film.

It is therefore extremely doubtful whether the slightly superior image resolution with 35 mm. film gives enough improvement in clinical diagnostic quality to justify the added expense of film, camera, projection equipment, and radiation dose to the patient.

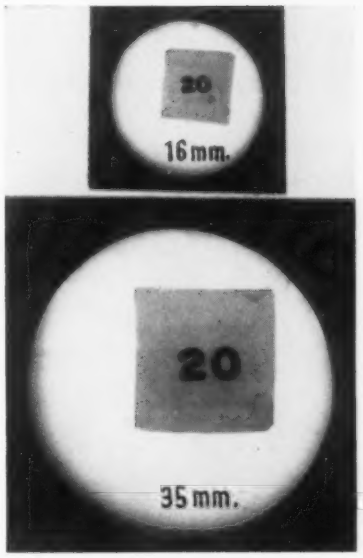

Fig. 4. Comparison of image resolution using 16 mm. and 35 mm. cinefilm size. The 20 line pairs per cm. resolved by the 35 mm. image size (20 mm. diameter) are not resolved by the 16 mm. image size (10 mm. diameter), although the difference is slight.

KILOVOLTAGE AND GRIDS

While high kilovoltage is useful in reducing radiation dose, especially in the study of thick parts, this may be accompanied by a critical loss of image contrast. It should be remembered that, even at best, the image contrast of cineroentgenograms does not approach that obtained with conventional roentgenography. Experience has shown a loss of contrast when kilovoltage values higher than optimum levels are used. This is especially noticeable when films of lower gamma values are employed to record areas showing low initial contrast.

To achieve better image quality, it is frequently better to use lower kilovoltage and high contrast cinefilm emulsions, even though this necessitates some increase in radiation dose.

Contrast may also be enhanced by the use of grids, but this requires an increase in radiation of 2 or 3 times, depending on the ratio and density of the grid used. Experience has shown that the slight improvement in image quality does not justify its routine use with the 5 inch amplifier. With the 8 inch amplifier, however, the scattered radiation incident to the larger field size often necessitates the use of a low density 8:1 grid in order to obtain satisfactory image detail.

FILM PROCESSING

An ideal developing solution should enhance the contrast and bring out the ultimate speed of the film emulsion. X-ray developer is best suited for this purpose. The film speed is increased two to three times when x-ray developer is used as compared to fine grain developers, and the contrast is improved (Fig. 5, *A* and *B*). Another prac-

* This factor assumes the use of conventional lens systems.

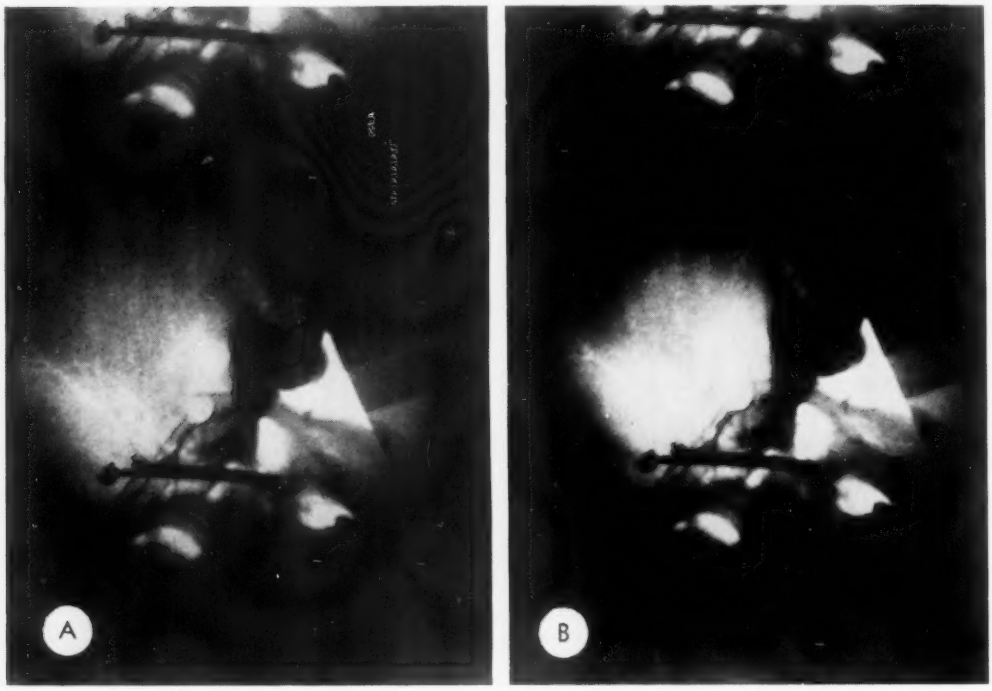

FIG. 5. Comparison of density of image obtained with fine grain developer (*A*) and x-ray developer (*B*). The density is greater with x-ray developer used at 68° F. for five minutes.

tical advantage of x-ray developer is its easy availability to the radiologist.

Cinefilms may be wrapped around a film hanger and hand processed for five minutes at 68° F. in x-ray developer. Following fixing and washing, the film may be air dried on an inexpensive drum type drying rack. For a larger volume of film, this is easier to accomplish in an automatic processor with accurate time and temperature controls.

EXPOSURE TIME

The exposure time for each cineframe should be sufficiently short to reduce the motion unsharpness to a minimum because of the large magnification factors involved in recording and projecting the images. This can generally be accomplished with exposure times of 1/60 to 1/120 second for respiratory and intestinal motions. However, for greater degrees of tissue motion such as occur with the movement of heart valves in cardioangiography (5–10 mm./sec.), the unsharpness is apparent at 1/60 second exposure. If the filming speed is reduced to 15 or 7½ frames per second to reduce radiation exposure, the unsharpness may be objectionable. The duration of this exposure time is determined either by the camera filming speed, the aperture of the camera shutter or the adjustment of the pulsing circuit of the timer. A thyrotron pulsing unit gives an exposure of 1/15 second at 7½ frames per second, 1/30 second at 15 frames per second, 1/60 second at 30 frames per second, 1/120 second at 60 frames per second, etc. If two valve tubes are cut out of a four valve rectifying circuit, then the pulsing unit will receive half-rectified current which, in turn, will reduce these exposures to 1/120 for 30 frames per second, 1/40 for 15 frames per second, and 1/18 for 7½ frames per second. To further reduce the exposure time at 15 and 7½ frames per second, a 1/60 second timer can be interposed between the camera gear and the thyrotron pulsing tube. This will give 1/120 second exposures at all filming speeds.

The advantage of 1/120 second expo-

TABLE IV

COMMON CINE-IMAGE DEFECTS AND CORRECTION FACTORS

Defect in Image	To Correct
1. Excessive Mottling, Scintillation, or Graininess	a. Increase radiation input b. Use slower fine grain film c. Use slower camera lens or stop decrease lens aperture d. Use neutral density filters
2. Vignetting—Loss of Peripheral Density	a. Use better quality lens system b. Use low contrast film c. Decrease lens aperture
3. Image Blurring	a. Refocus image tube b. Refocus camera lens c. Shorten exposure time d. Use smaller focal spot e. Decrease object-image tube distance
4. Poor Contrast	a. Use high contrast film b. Decrease kilovoltage c. Use grid for thick parts d. Use high contrast developer
5. Excessive Magnification	a. Lengthen target-table top distance b. Decrease object-image tube distance

sures in improving image detail is greater when there is a large tissue motion factor at slower filming speeds. It is possible that some of the gain in diagnostic quality obtained at 60 frames per second is due to the faster exposure time (1/120) that is obtained with this filming speed.

SUMMARY

Adequate image quality for clinical diagnosis may be obtained with reasonable radiation dosage (0.6 r to 26 r/min.)[5] from 16 mm., image intensified, cineroentgenography when certain technical factors governing image formation are properly utilized. While any of the 10 factors described may independently alter the character of the image, the summation of their effects determines the final image quality.

By and large, the most frequent causes of poor cine-image quality are (1) the excessive scintillation of a high brightness gain image tube at low radiation inputs, and (2) the vignetting effects resulting from a poor optical system in combination with high contrast film emulsions.

Correction of a poor image should be approached by analyzing the type of fault present and then adjusting the factors which may influence it. Table IV lists the image defects which may be encountered and the factors which the radiologist should investigate to correct them.

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The authors wish to acknowledge the technical assistance in this research received from Mr. Ivan Gambrel of Picker X-Ray Corporation, Mr. Arthur Kistner of Dick X-Ray Company, and Mr. W. M. Riley of Keleket X-Ray Corporation and Mr. Alfred Lignon of North American Philips Company.

REFERENCES

1. Campbell, J. A., and Klatte, E. C. Current status of cinefluorography in cardiac diagnosis. *Progress in Cardiovascular Diseases*, 1959, 2–1, 20–35.
2. Garrett, R. A., and Klatte, E. C. Cineurography. *J. Urol.* (In press.)
3. Glore, James F. (Medical Illustrations, Indiana University Medical Center). Personal communication.
4. Hallock, A. C. (Machlett Corporation, Chicago, Illinois). Personal communication.
5. Klatte, E. C., Campbell, J. A., and Lurie, P. R. Technical factors in selective cinecardioangiography. *Radiology*. (In press.)
6. Tol, T., and Oosterkamp, W. Visibility of x-ray quantum fluctuations on image intensifier radiographs. *Nature*, 1954, *174*, 397–398.
7. Watson, J. S., and Weinberg, S. A. Presented at the First Annual Symposium on Cinefluorography. Rochester, New York, November, 1958.

REPRODUCTION OF ROENTGENOGRAMS ON 35 MM. DIRECT POSITIVE FILM FOR PROJECTION*

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AN UNCOMPLICATED inexpensive method for reproducing roentgenograms on 35 mm. Kodak Direct Positive Film has been developed and used in our department for several years. Malcolmson[2] recommended direct positive film for this purpose and considered the detail of the reproductions to be superior to that on films commonly used. The intermediate step of the conventional black and white method was eliminated and the cost of the reproductions substantially reduced. Kodachrome Film has been used as described by Gibson[1] but the required pre-exposure, time delay in processing, cost, and blue background were considered major disadvantages. Reproducing roentgenograms on $3\frac{1}{4}\times4$ inch Polaroid Land Projection Film was tried and discarded due to the slightly inferior quality of the reproductions, blue background, and cost.

The greatest usefulness of Kodak Direct Positive Film reproductions is in radiologic teaching conferences where a viewbox presentation would be inadequate and projection of the original roentgenograms by other methods is unsatisfactory. This method has been employed to advantage in teaching students by supplementing the basic teaching films with 35 mm. slides of roentgenograms. Diagrams, pictures and pathologic specimens may be photographed by adding photoflood lights to the basic setup for reproducing roentgenograms. These may be used for explanation, sequentially with roentgenographic slides, or for roentgenographic-pathologic correlation.

The material for a complete conference can be photographed, developed, and mounted in approximately three hours. Provided thirty-six exposures are made on each roll of film, the average time spent per mounted slide is five minutes. A major portion may be done by an x-ray technician trained to develop and mount the films. Photography is done by the radiologist. The additional time required to photograph the original films is short if a single lens reflex camera is used. Close-up views of a specific area such as the sella turcica may be easily obtained. Such views are invaluable in demonstrating smaller segments of a roentgenogram in detail. The reward of presenting roentgenograms and specimens in this manner more than compensates for this additional time.

Since Direct Positive Film is of very fine grain, reproductions can be used to make black and white enlargements for publications. This involves making a negative from a positive and printing the negative. The reproductions are excellent and inexpensive.

It is the departmental practice to require the residents to photograph their own films for conferences. This familiarizes the young radiologist with the use of photographic equipment and processing. The technique can be used to good advantage not only during residency training but also as a practicing radiologist.

EQUIPMENT

A single lens reflex 35 mm. camera is desirable. Any 35 mm. camera with an accurate bulb time for over 1/25 of a second may be used. We employ an Exakta camera with a 40 mm. Macro-Kilar E lens, but a 50 mm. lens with a portrait lens attachment may also be employed. The use of a portrait lens without some type of focusing device requires additional information regarding the area or field to be photographed at a given lens to film distance. If required,

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TABLE I

COST DETERMINATION OF EQUIPMENT

Camera and Accessories	$ 75.00–$400.00
Viewbox	30.00
Clamp and Pole	12.00
Light Meter	18.00– 35.00
Masks	3.00
Daylight Loader	6.00– 12.00
Daylight Developing Tank	6.00
Chemicals (for eight 36 exposure rolls)	3.20
Mounts, 24×36 mm. per 100	1.50
Direct Positive Film (700 exposures)	7.90
Iron	8.00
	$170.60–$518.60

the camera level necessary to encompass different film sizes may be marked on the upright stand.

A horizontal roentgenographic viewbox and an upright stand securely fastened to a table or heavy platform are necessary to eliminate motion. A sturdy tight fitting clamp to secure the camera to the stand is essential. The viewbox, stand and light arrangement are shown in Figure 1. The upright stand perpendicular to the long axis of the viewbox is commonly used for reproducing roentgenograms by this process. The other stand has been used for the Polaroid camera and for 16 mm. movie time studies for consecutive roentgenograms.

A light meter* with a sufficiently sensitive photoelectric cell is needed for the wide variations of light intensities encountered on roentgenograms. A cable release is desirable to prevent jarring of the camera as the exposure is made.

A daylight developing tank eliminates prolonged darkroom time. Chemicals and instructions for processing are included in the Kodak Direct Positive Processing kit. Mounting is done in 2×2 inch mounts for 24×36 mm. transparencies. Many 2×2 inch slides may be stored in a small space. A system of filing is essential as the departmental or personal collection increases.

* Weston Master II and III light meters have been used and found satisfactory.

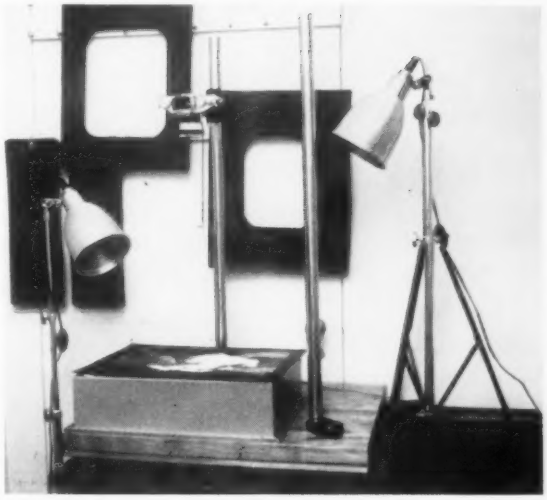

FIG. 1. The camera viewbox setup. A roentgenogram and mask are on the viewbox. The photoflood lights are used to copy diagrams and specimens.

Kodak Direct Positive Panchromatic Film is a fine grain, antihalation reversal film and must be handled in complete darkness. The American Standard Association (ASA) exposure index for artificial light is 64. The film is obtainable in 100 foot rolls, necessitating a daylight bulk film loader for each roll cassette of 36 exposures or less. Kodak 35 mm. Panatomic X-Film may be used as a substitute. It has the same ASA rating and is developed by the same reversal process except that the time in the first developer is eight minutes and the final wash only ten minutes. Excluding the original equipment and labor, the actual material cost per mounted slide is $0.04.

TECHNIQUE

To make 35 mm. copies the camera is loaded with Direct Positive or Panatomic X-Film, fastened to the clamp and centered on the viewbox. The camera diaphragm is opened to its maximum diameter to permit more critical focusing. The meter reading for reflected light is obtained about 4 inches below the lens. For extreme closeups the meter reading is obtained just below the lens. Using the exposure index of ASA 64, various correction factors for varying quality roentgenograms have been

TABLE II

FULL STOP REDUCTIONS IN APERTURE OPENING FOR DIRECT POSITIVE FILM REPRODUCTIONS*

Anatomic Part		Quality of Film		
		Low Contrast	Normal Contrast	High Contrast
Skull (all projections)		3	2	1
Mandible (all projections)		2	1	0
Chest and Ribs	posteroanterior	1	0	0
	oblique	2	1	0
	lateral	2	1	0
Abdomen, Pyelograms, Vertebrae	all projections	1	½	0
Gastrointestinal Tract with Barium		1–2	1	½
Extremities		3–4	3	2–3

* The numbers indicate the number of full stops that the aperture should be reduced in size to obtain the correct exposures. For example, the meter reading indicates that a lateral skull of low contrast should be exposed at 1/25 second with an aperture of f. 4. Using the correction factor, the correct exposure is 1/25 second at f. 11. Low contrast refers to white and a short range of grays. High contrast means black and white and a short range of dark grays.

carefully worked out and are found in Table II. All numbers indicate the number of full stops; the aperture should be closed beyond that indicated by the light meter before the exposure is made.

Without changing the distance, the diaphragm is closed to the desired aperture and the correct time selected. The longest convenient time and smallest lens aperture are used to increase the depth of field.

Heavy black cardboard masks improve the appearance of the film margins and eliminate excessive light from the edges of the viewbox. These will maintain the films in a flat position while being photographed.

As the technique is being established, it is desirable to keep a detailed record of the time, aperture size, meter reading and quality of the roentgenogram and reproduction obtained in order that corrections may be made if necessary.

SUMMARY

An inexpensive, uncomplicated, completely intra-departmental method for making 35 mm. reproductions of roentgenograms of excellent quality is discussed. The slight disadvantages are the increased time the physician spends in photographing films and the initial expense met in the purchase of equipment. The final low cost of each slide and marked improvement for radiologic demonstrations more than offset these disadvantages.

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REFERENCES

1. GIBSON, H. L. Copying radiography with miniature Kodachrome Film. *M. Radiog. & Photog.*, 1951, *27*, 125–128.
2. MALCOLMSON, P. H. Direct positive micro-film for reproduction of radiographs. *Canad. M. A. J.*, 1942, *46*, 68–69.

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REDUCED GONADAL IRRADIATION IN PRENATAL CHEST ROENTGENOGRAPHIC EXAMINATIONS

By LEWIS E. ETTER, M.D.,* CHARLES N. CHASLER, M.D.,† *and* LAWRENCE C. CROSS, R.T.‡
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PRENATAL roentgenographic examinations are used extensively in obstetric practice. Where these are conducted under the supervision of competent radiologists, the value of information they yield, both to the physician and his patient, far outweighs the theoretic genetic damage to the mother and fetus.* Nevertheless, it is desirable to reduce these radiation doses to the lowest possible values consistent with satisfactory diagnostic results.

At present, in most hospitals and radiologic diagnostic clinics, it is common practice to make a 14×17 inch posteroanterior roentgenogram of the chest of the expectant mother at about seven months. Figure 1*A* shows such a roentgenogram which in about 98 per cent of cases, exposes more of the abdomen and fundus of the uterus than is necessary. It is obvious that at least 3 inches can be cut off the bottom of the film without loss of a single detail required in a chest roentgenogram. For comparison, Figure 1*B*, a 14×14 inch posteroanterior roentgenogram of the chest of the same patient is shown. The technician has positioned the patient higher on the film-cassette to avoid waste of the area above the shoulders. On this roentgenogram the thorax and its contents are well visualized. It represents 18 per cent less surface area than in Figure 1*A* and delivers, with exact collimation of the roentgen rays, about a 20 per cent smaller dose of radiation to the vital areas of the body. In about 80 per cent

* Adrian Committee, Great Britain, Interim Report. No curtailment of mass miniature radiography necessary. Reported in *Scope*, May, 1959, *1*, 20.

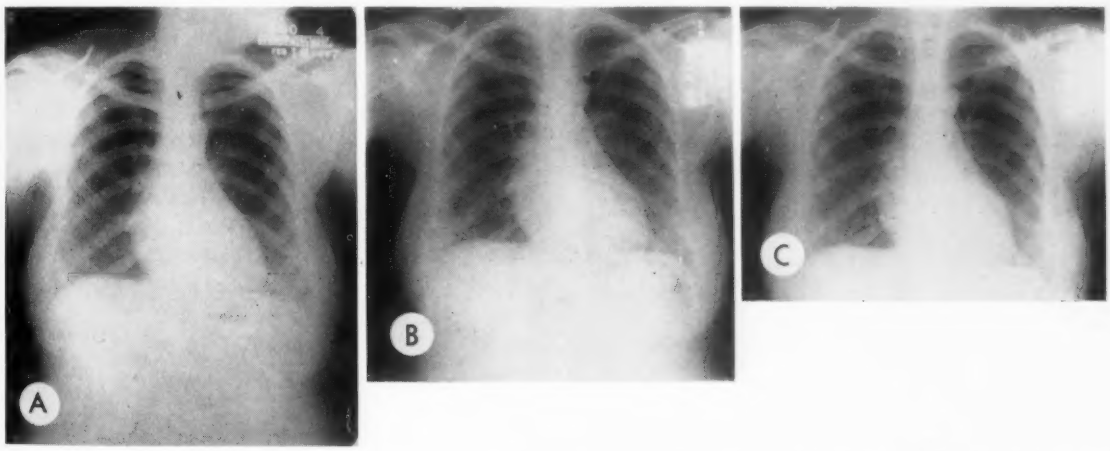

FIG. 1. (*A*) A conventional 14×17 inch posteroanterior chest roentgenogram showing useless film area above shoulders and unnecessary exposure below the diaphragm. (*B*) Posteroanterior chest roentgenogram showing better positioning of the patient on a 14×14 inch film with square beam collimation. However, the unneeded film over the abdominal and uterine fundus area can further be eliminated. (*C*) Posteroanterior chest roentgenogram showing that in many pregnant women, the thoracic region can be completely visualized on a 14×11 inch film.

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† Assistant Professor of Radiology, School of Medicine, University of Pittsburgh, and Radiologist at Elizabeth Steel Magee Hospital, Pittsburgh.
‡ Research X-Ray Technician, Western Psychiatric Institute, University of Pittsburgh.

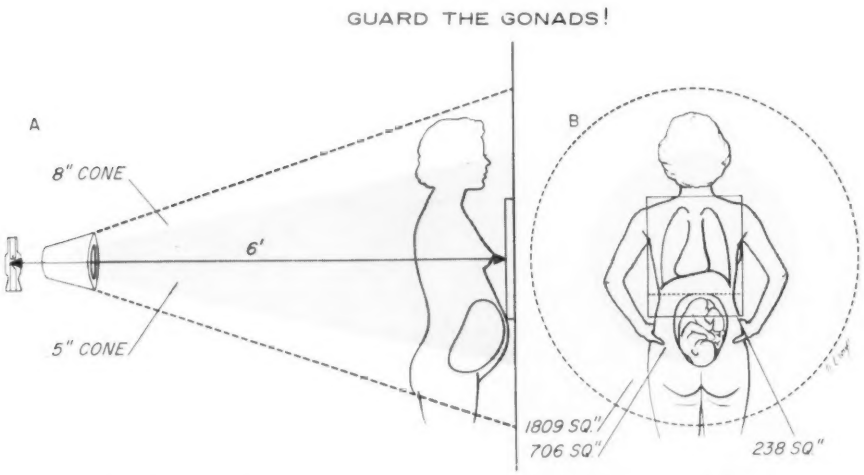

FIG. 2. (*A*) Diagram of a typical roentgenographic examination of the chest using either an 8 inch or 5 inch cone to cover a 15×18 inch cassette. (*B*) Diagram showing unnecessary exposure of the upper abdomen as well as other parts of the body.

of women, the supradiaphragmatic portion of the thorax can be demonstrated on a 14 by 11 inch roentgenogram such as is shown in Figure 1 *C*. When compared to Figure 1*A*, this represents a saving of about 25 cents per film and has a 36 per cent reduction of the area of exposure when proper rectangular collimation of the roentgen-ray beam is used.

The usual technique of a prenatal roentgenographic examination of the chest is indicated diagrammatically in Figure 2. An 8 inch, or more properly, a 5 inch cone limits the beam of radiation. Even with this modification and safeguard, large areas of the patient's body are unnecessarily exposed to radiation. If instead of a cone a rectangular or square collimator is used in the roentgen-ray beam (Fig. 3), the area irradiated is greatly reduced and a much smaller dose is given to patient and fetus.

Figure 4 shows graphically how rectangular and square beam collimation, in addition to aluminum and copper filters,[1,2] progressively reduces the dosage. Since the gonads will usually be in the direct beam of

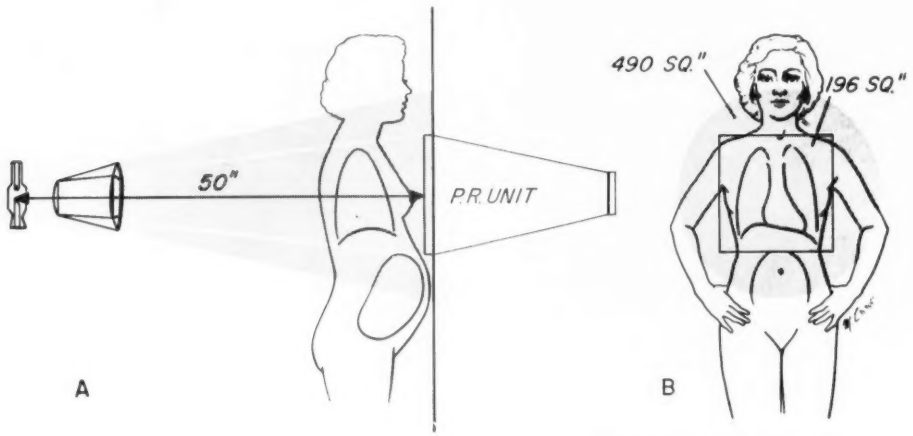

FIG. 3. (*A* and *B*). Diagrams illustrating the use of square collimation of the roentgen-ray beam. The uterine fundus is avoided while the necessary thoracic area is included.

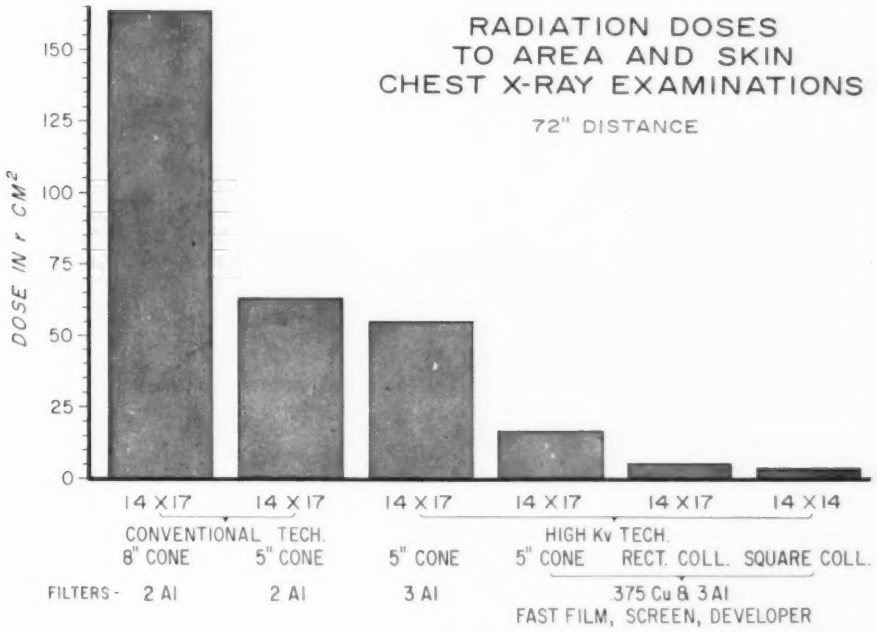

Fig. 4. Bar graph showing the radiation doses to skin area when the chest is roentgenographed with a conventional technique using an 8 inch cone or a 5 inch cone, 2 mm. of aluminum filtration and a 14×17 inch film. Comparison of this technique with one using added filter, fast films, fast screens, fast developer, and additional copper as well as aluminum filtration with rectangular and square beam collimators indicates a tremendous reduction in skin area dose.

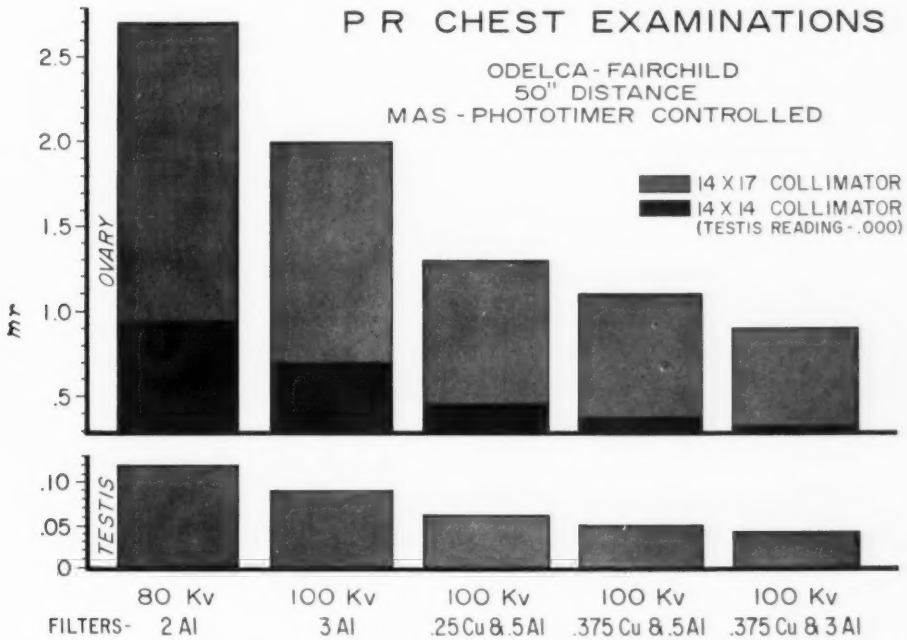

Fig. 5. Bar graph showing the doses delivered to the gonads when the Odelca Fairchild Photoroentgen machine is used for chest roentgenography. A comparison is made between 14×17 inch collimation and 14 × 14 inch collimation with added filtration. The latter achieves a negligible dose to the ovary and a vanishing dose to the testes. These data regarding male gonads were included as the apply to other photoroentgen chest examinations.

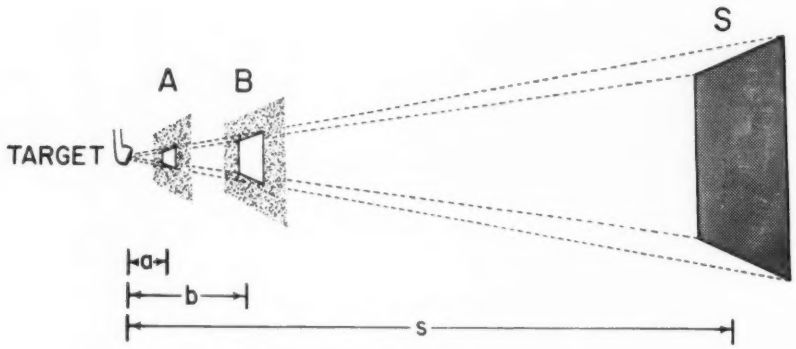

FIG. 6. Diagram showing the dimensions of square apertures for collimating roentgen-ray beams of photoroentgenographic machines. The general relationships are as follows:

$$\frac{A}{a}=\frac{B}{b}=\frac{S}{s}$$

where A = opening of aperture (cm.) closest to target; B = opening of aperture (cm.) farthest from target; S = length (cm.) of side of screen; a = distance (cm.) from target to aperture A; b = distance (cm.) from target to aperture B; s = distance (cm.) from target to aperture screen S.

For 40 inches (101.6 cm.) these values are as follows: a 10.00 cm.; b 25.00 cm.; s 101.70 cm.; A 3.50 cm.; B 8.75 cm.; S 35.56 cm.

For 50 inches (127.0 cm.) they are: a 10.00 cm.; b 25.00 cm.; s 127.00 cm.; A 2.80 cm.; B 7.00 cm.; S 35.56 cm.

(Formulae through the courtesy of Professor Gene E. Geiger, Department of Mechanical Engineering, University of Pittsburgh.)

radiation in cases of cephalic presentations, this reduction of dose and pinpoint accuracy of positioning are of particular importance in prenatal roentgenography. A sharply collimated beam of roentgen rays directed above the uterine fundus, moreover, eliminates the need for lead apron shields, although, of course, it does not completely prevent internal scatter.

A somewhat greater dose of radiation to the patient and the fetus is given in photoroentgen chest examinations than in the usual 6 foot chest roentgenography (Fig. 5). The reason for this is the shorter distance (40–50 inches), the use of an optical system and a longer time of exposure. By using square cut-out lead diaphragms, this roentgen-ray beam can be accurately collimated (Fig. 6), and a smaller adequate area of the chest irradiated, sparing the gonads of mother and fetus. If a rectangular 11×14 inch area is collimated for the photoroentgen examination the dose to the fetal gonads can be reduced up to 92 per cent.* When a 4×4 inch film instead of a 4×5 inch film is used, a 20 per cent saving in cost is effected. The insertion of additional filters, as described above and shown in the bar graphs of Figures 4 and 5, achieves a marked reduction in dose.

In Figure 7 are reproduced a number of 4×5 inch photoroentgenograms in which there is obviously too much of the abdomen and fundus of the uterus included in the area of irradiation. By using square cut diaphragms and 4×4 inch films as previously described, this irradiated area is reduced by 20 per cent, yet all of the thoracic contents necessary for diagnosis are visualized (Fig. 8).

When a comparison is made of the large

* With a 14×17 inch collimated area at 80 kv., inherent filter only, the dose to the fetal gonads as measured in a mannikin was 10.0 mr. By using a 14×14 inch collimated area, 120 kv., 0.375 mm. Cu and 3 mm. Al filter, the dose was reduced by 32 per cent, to 7.0 mr. With the same exposure factors but an 11×14 inch collimated area, the dose to fetal gonads was reduced 92 per cent, to 0.80 mr.

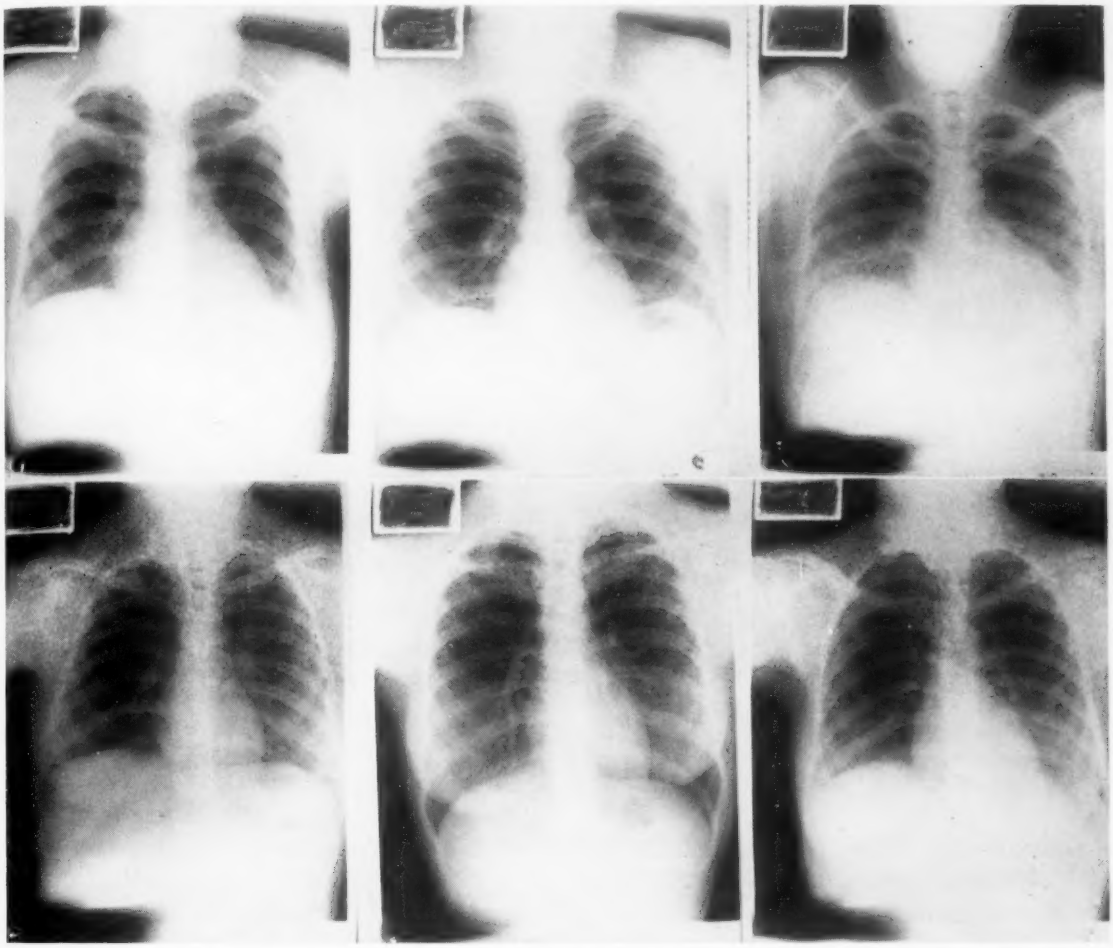

Fig. 7. Conventional 4×5 inch photoroentgenograms of chests made in the last trimester of pregnancy. Too much film is wasted above the shoulders and beneath the diaphragm. The uterine fundus is included in the field of direct radiation.

14×17 inch films with the 14×14 inch ones, a considerable economic saving is evident. A standard box of seventy five 14×14 inch films can be purchased at approximately $10.00 less a box—a saving of about $0.13 a film, which when multiplied by the thousands of roentgenograms taken represents a significant amount in lowering costs. It is not necessary to buy new cassettes for these smaller films as they may be securely held in the uppermost portion of the 15×18 inch standard size cassettes. It is, however, necessary to buy 14×14 and 11×14 inch processing hangers. The film sizes above described are commercially available.

SUMMARY

A method for reducing gonadal irradiation in prenatal chest roentgenography is presented. It is recommended that:

1. The standard large chest roentgenograms be made with 14×14 inch films instead of the 14×17 inch ones which are presently in use.

2. A 4×4 inch photoroentgenographic film be substituted for the 4×5 inch one, especially in examinations of pregnant women. The photoroentgen unit beam should be collimated to a 14×14 inch or 11×14 inch area.

3. All roentgen-ray beams be collimated

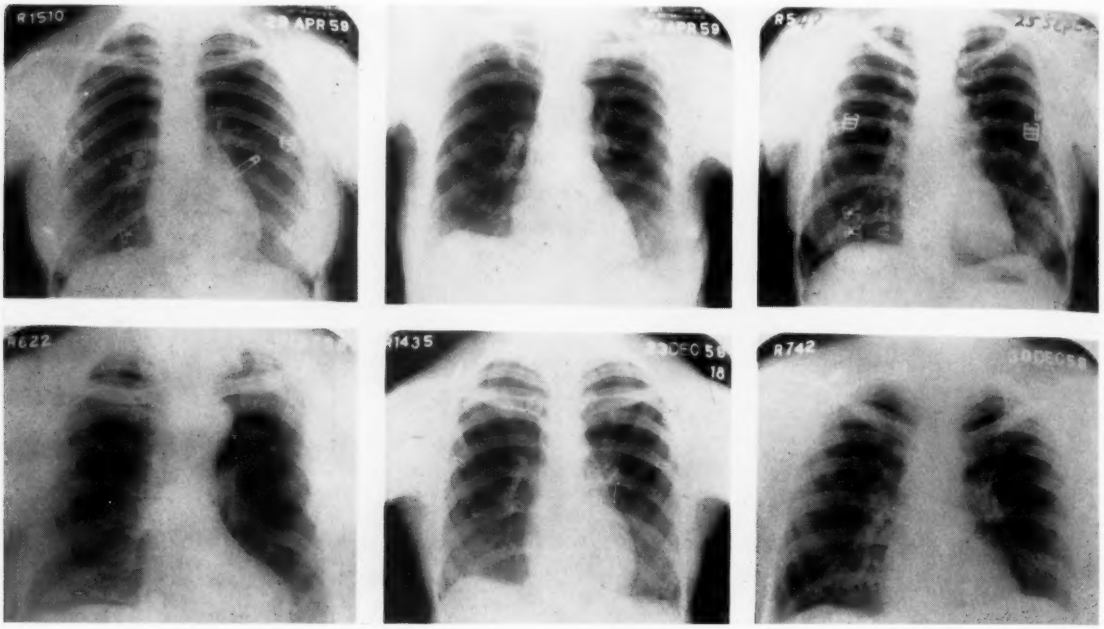

FIG. 8. Photoroentgenograms made with Odelca Fairchild unit showing use of rectangular roentgen-ray beam collimation with a sharp cut-off beneath the diaphragm. The patients are positioned higher on film so that less of available area is wasted.

in squares or rectangles to the exact area of interest.

4. More filtration, combining copper with aluminum, be used to lower gonadal doses to negligible amounts.

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REFERENCES

1. ETTER, L. E., SIDHU, S. S., and CROSS, L. C. Radiation dose reduction in dental roentgenography. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1958, *80*, 926–932.
2. ETTER, L. E., KAMMER, A. G., DATTOLI, J. A., CEMBER, H., GRIFFITH, C. R., and CROSS, L. C. Radiation reduction by combined copper and aluminum filtration in radiography. *Radiology*, 1959, *72*, 863–867.

SILVER RECOVERY WITH THE X-OMAT*

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THE purpose of this paper is to communicate our experiences in a study dealing with silver recovery after the installation of an Eastman Kodak X-Omat unit at Montefiore Hospital, early in 1958. Such a presentation is believed timely, since there are about 200 X-Omat units currently in operation in the United States.

The X-Omat is particularly well suited to a silver recovery program since the overflow of used fixer from this unit can easily be collected at a central location. Film passing through the X-Omat closes a microswitch which activates the replenisher pump and delivers fixer replenisher into the machine's fixer tank. At the same time, a corresponding volume of used fixer is displaced through an overflow.

At Montefiore Hospital from 800 to 1,000 films of assorted sizes are processed daily, producing about 12 gallons of used fixer overflow in this period. We determined that the silver content of the used fixer from our X-Omat assayed 1.0 to 1.3 troy ounces per gallon. At this rate, more than 12 troy ounces of potentially recoverable silver are released daily from the films to the fixer during processing. The silver content of fixer overflow from the X-Omat varies with the replenishment rate used and the sizes and density characteristics of films processed.

The used fixer can easily be collected by running a length of Tygon plastic tubing from the fixer overflow cup to a collecting barrel. At Montefiore Hospital, the 9 inch long fixer overflow tube which joins the fixer overflow cup to the wash water overflow trough was disconnected at this trough. The loose end was then connected to a new piece of smaller diameter tubing ($\frac{1}{4}$ ID$\times\frac{1}{16}$ Wall), the same diameter as that used in the X-Omat replenisher pump (Fig. 1). The new tubing was run through the replenisher pump (Fig. 2) and into a 55 gallon collecting barrel. As a result, the replenisher pump, when activated, forces fresh fixer replenisher into the X-Omat fixer tank and simultaneously pumps the corresponding volume of used fixer from the overflow cup into the collecting barrel. A 55 gallon rubber lined steel drum furnished by the refiner is used as a receiving vessel.

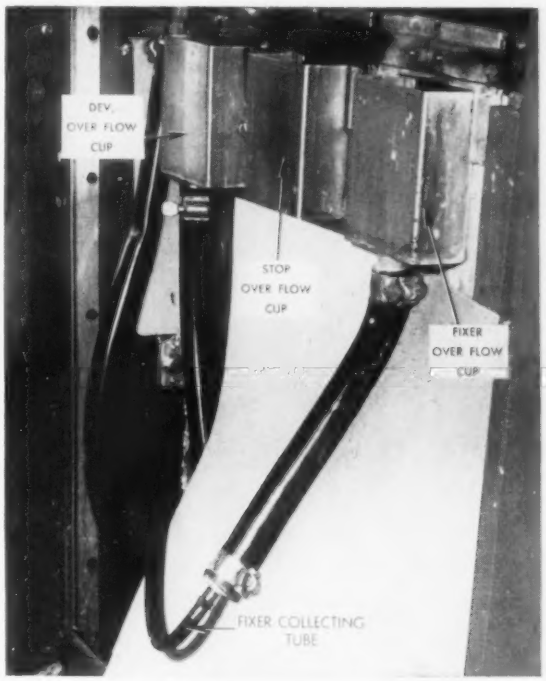

FIG. 1. X-Omat fixer overflow cup connected for silver recovery to fixer collecting tube which leads to fixer recovery tank.

If the level of the collecting container used is well below the level of the X-Omat fixing tank, simple gravity flow is sufficient and it is not necessary to run the fixer collecting tube through the replenisher pump.

It is not our purpose to recommend that

* From the Division of Diagnostic Radiology, Montefiore Hospital and the Department of Radiology, New York University College of Medicine, New York, New York. The data herein presented have been worked out with the Model M X-Omat. Since this paper was submitted for publication, a Model M-3 X-Omat has been introduced using a different chemical system. However, the fundamental concepts of silver recovery should apply to this new unit with certain chemical modifications.

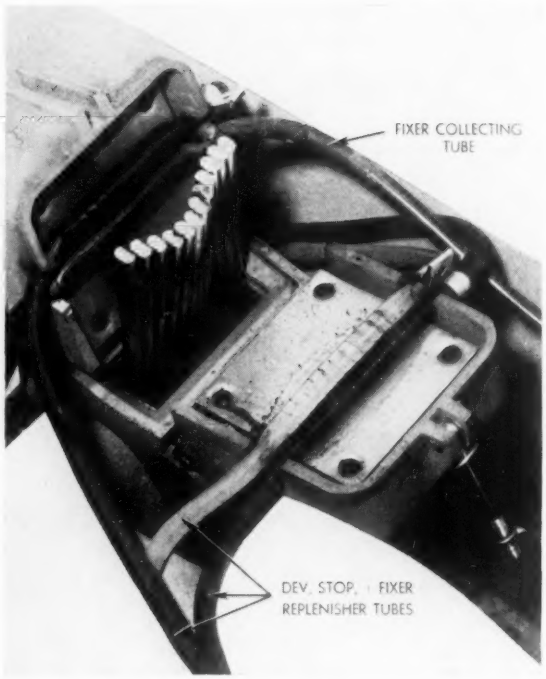

FIG. 2. The X-Omat replenisher pump is shown with the added fixer collecting tube in place. When the pump is activated, fresh fixer is forced into the X-Omat and the fixer overflow is pumped into the collecting barrel.

a hospital either sell the collected used fixer in bulk form or recover the silver in the Radiology Department electrolytically from the used fixer, selling the metallic silver to a refiner. Both methods have been used at Montefiore Hospital. Refiners in the New York City area add a refining charge of about 40 per cent when they collect used fixer solution in bulk from the hospital. The refining charge from metallic silver recovered electrolytically amounts to only about 5 per cent with the market price for metallic silver at the time of this study being 90¢ per troy ounce. On the other hand, to recover the silver electrolytically in the Radiology Department requires some time and effort, even if slight.

To evaluate the problem of electrolytic silver recovery, we studied the types of recovery units available commercially. Basically, electrolytic silver recovery units contain stainless steel collecting cathodes, carbon rod or carbon sheet anodes and a D.C. rectifier. Some commercially available units incorporate a method of agitating the fixer while others do not. Those that operate at low currents[8] (up to 1 ampere) generally do not include a method for mechanical agitation. The low current agitating units are furnished free by some dealers, who, in turn, retain a part (about 50 per cent) of the silver collected by the unit to cover installation and maintenance cost. Low current units may be purchased outright from at least two manufacturers for about $300.00 each. Units employing higher current (as high as 15 amperes) provide for mechanical agitation of the fixer.[2,3] Sulfurization of the fixer is prevented by the mechanical agitation.

The first unit tried at Montefiore Hospital (a low current unit) did not incorporate a method for agitating the fixer and is shown in Figure 3. It was found that with the rectifier set no higher than 1 ampere this unit worked satisfactorily, although in twenty-four hours only about $2\frac{1}{2}$ troy ounces of silver were recovered. The collecting cathode illustrated in Figure 3 is a stainless steel plate. The addition of a folded stainless steel screen cathode and a 4 ampere rectifier was tried subsequently to increase the recovery rate but there was no significant improvement in results. Without agitation the fixer sulfurized, even though silver still remained in the fixer. However, low current units may prove adequate in departments that process less than 250 films daily.

Since the amount of silver plated per hour is directly proportional to the current density and since mechanical agitation increases the silver yield, we decided to utilize a commercial unit having a variable rectifier adjustable from 1 to 15 amperes with the required agitation provided by the rotation of the stainless steel collecting disks (Fig. 4). Such units may be purchased from at least three different manufacturers for $400.00 to $600.00 each. With a current setting of 10 amperes, about 1 troy ounce of silver is removed per hour. A yield of metallic silver weighing 20 pounds and assaying 98.8 per cent is shown in Figure 5. The silver was removed from the collecting

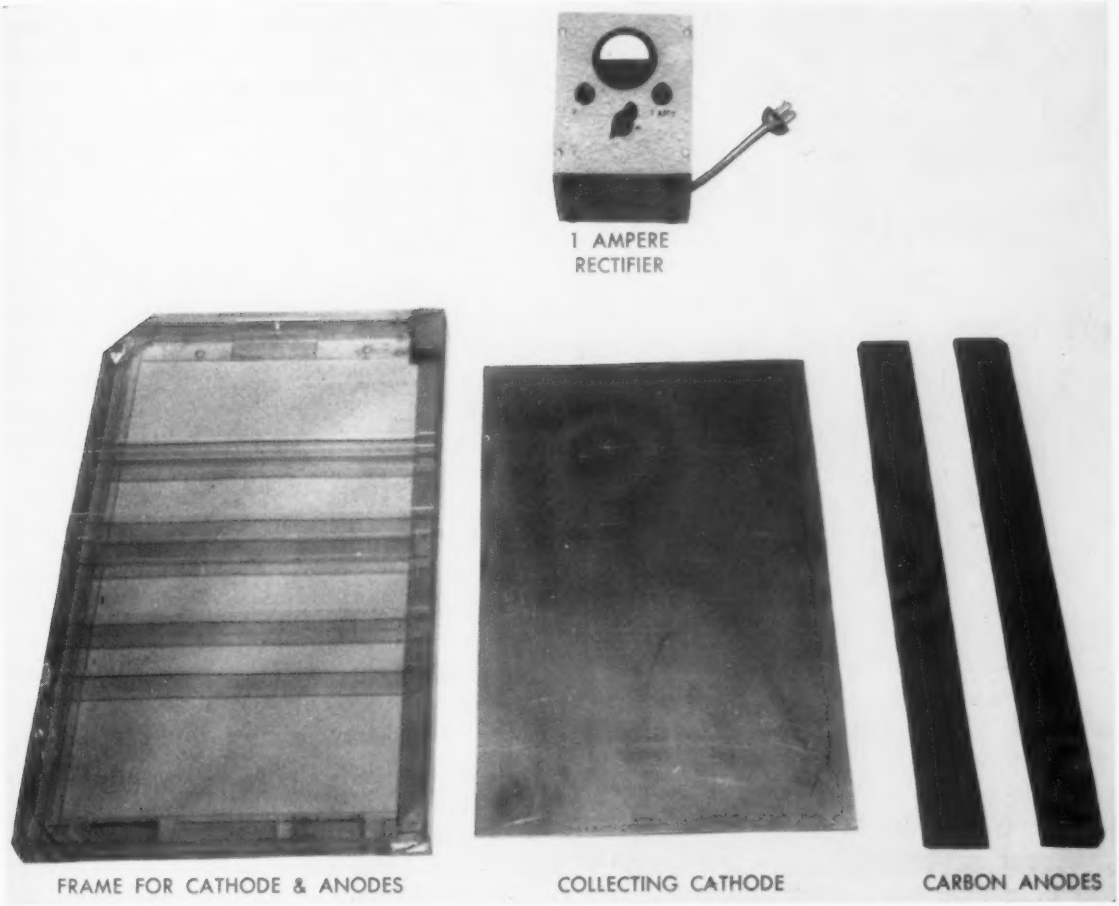

Fig. 3. Component parts of a silver recovery unit which does not incorporate a method for agitating the fixer.

plate by simply flexing the disks at no oftener than monthly intervals.

Two simple visual indicators can be used to determine when all the potentially recoverable silver has been removed: (1) if a strip of highly polished copper is dipped into the waste fixer containing silver, silver will plate the copper within five seconds. Once recovery has been effectively completed, silver will not plate the copper indicating strip, even if left in the fixer for ten seconds; (2) while silver is in solution and plating is taking place, the disks are of a light, whitish cream color. The plates turn grayish black shortly after the recoverable silver has been removed. With a little experience, an observer can determine how long to operate the silver recovery unit, just short of a change in plate color. A simple laboratory timer can then be used to automatically turn off the unit after a predetermined interval. Accurate quantitative determinations of the amount of silver may be carried out by the hospital laboratory, if desired.*

Because of currently generated interest in the problem, consideration was given to the re-use of fixer in the X-Omat after silver recovery.

The chemical theories of electrolytic silver recovery and the regeneration of conventional acid-hardening fixing baths with the starting pH of about 4.5 have been thoroughly covered in the literature.[3,4,6,7] Special fixers for the X-Omat have a starting pH of about 6.5 and are compounded with ammonium thiosulfate as a fixing agent in advance to achieve rapid fixing. The preceding stop bath of the X-Omat has a much lower pH and contains a high

* Methods of quantitative silver analysis are available on request from various recognized chemical manufacturers.

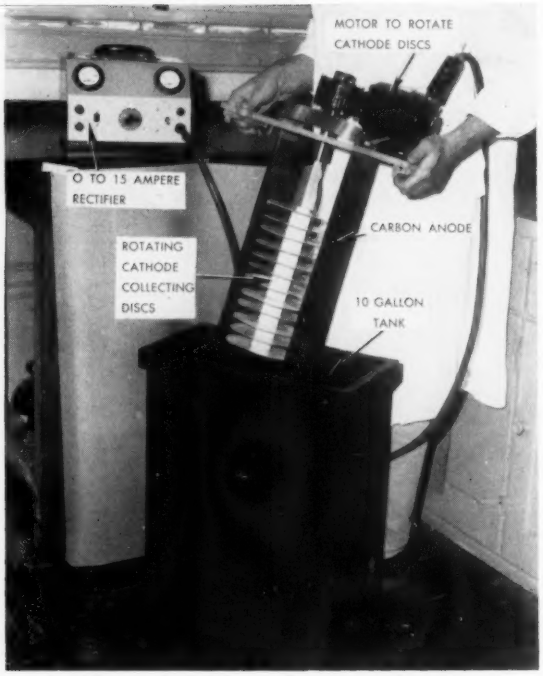

FIG. 4. Commercially available recovery unit (high current) in which collecting plates rotate to agitate the fixer.

concentration of hardener. Roentgenographic film with a thiosulfate content of less than 0.04 mg. per square inch is considered to be of satisfactory archival quality.[9] Films processed in the X-Omat in these special fixers will meet this archival standard. We noted that the pH of the used fixer dropped appreciably during silver recovery at Montefiore Hospital. A pH of 5.7 was found after ten hours of operation of the silver recovery unit, while a pH as low as 3.9 was noted after several days of operation. Films processed in fixer with a pH lower than 6.2 failed to meet both commercial and archival standards when tested according to the American Standards Association method[1] and the Henn-Crabtree acid silver nitrate spot test[5] for determining residual thiosulfate. Film clearing time also increased noticeably and the specific gravity of the fixer changed. Swelling of the emulsion and changes in surface characteristics of the film may cause subsequent "jamming" in the X-Omat drying section. Discoloration of the fixer was also noted during these experiments,[10] caused by oxidation of carried-over developing agents at the anode during electrolysis.

In order to prevent these deleterious changes after silver recovery, the specific gravity of the used fixer may be adjusted to a value of 1.13 by adding fresh fixer concentrate and the pH increased to a value of 6.5 by adding liquid ammonia or caustic soda. We feel, however, that the saving in fixer usage with these additions does not justify the additional supervisory time required for such involved chemical controls in a fixer regeneration program, in order to provide trouble-free operation and satisfactorily washed films of adequate archival quality.

A good silver recovery program operating effectively will diminish the cost of the chemicals used in an X-Omat unit by approximately one-third since the value of the recovered silver is almost equal to the cost of the fixer used. In any large department, we have estimated that there may be a saving in the area of $2,000.00 to $4,000.00 per year from the sale of the recovered silver depending on the method used and the number of films processed. The information presented in this article is also applicable to departments with other types of automatic processing equipment—*i.e.*, the Pako and the Hill machines. As a guide, about 1 to 2 troy ounces of silver can be recovered from every 100 14×17 inch sheets of screen-type film or equivalent

FIG. 5. Collected metallic silver obtained from a high current, mechanically agitated unit.

that is processed. The silver content of used fixer from a manual tank rarely exceeds $\frac{1}{2}$ to $\frac{3}{4}$ ounce per gallon regardless of the amount of film processed, since so much silver-laden fixer is carried out to the wash water with the films.

SUMMARY AND CONCLUSION

1. The desirability of optimum silver recovery in the use of an Eastman Kodak X-Omat processing unit has been emphasized.

2. The relative values of nonagitating and agitating units have been discussed.

3. A simple and effective type of installation with a high current agitating unit in the Department of Radiology of the Montefiore Hospital has been fully described.

4. The dangers inherent in a program of fixer re-use after silver recovery when operated without proper safeguards have been stressed.

5. The monetary return in a typical silver recovery program has been presented.

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REFERENCES

1. American Standards Association: Method of Determining the Thiosulphate Content of Processed Photographic Film, PH 4.8, 1958. American Standards Association, Inc., 70 E. 45th St., New York 17, N. Y.
2. Cedrone, N. J. Silver recovery apparatus for operation at high current densities. *J. SMPTE*, 1958, *67*, 172–174.
3. Duisenberg, C. E. Silver recovery and prolongation of fixing baths. *J. SMPTE*, 1956, *65*, 429–431.
4. Goodes, H. G. Silver recovery and fixer regeneration. *Radiography*, 1952, *18*, 252–255.
5. Henn, R. W., and Crabtree, J. I. Reference scale for hypo determination in film with acid silver nitrate. *Photo. Sci. & Tech.*, Series 11, 1954, *1*, 83–84.
6. Hickman, K., Wyerts, W., and Goehler, O. E. Electrolysis of silver bearing thiosulphate solutions. *Ind. Eng. Chem.*, 1933, *25*, 202–212.
7. Hornsby, K. M. Electrolytic silver recovery. *Brit. J. Photo.*, 1957, Dec. 6, 698–701.
8. Rasch, A. A., and Crabtree, J. I. Electrolytic recovery of silver from fixing baths at low current density. *Photo. Sci. & Tech.*, Series 11, 1955, *1*, 15–33.
9. Russel, H. D. Rapid processing of x-ray film. *Photo. Sci. & Eng.*, 1959, *3*, 32–34.
10. Sharpe, C. J. Formation of coloured solutions during electrolysis of used fixing baths. *Brit. J. Photo.*, 1954, *101*, 140.

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EDITORIAL

THE IMPACT OF RAPID AUTOMATIC FILM PROCESSING ON A DEPARTMENT OF RADIOLOGY

RADIOLOGY has undergone many changes in the sixty-five years of its history. It has graduated from a fracture and foreign body diagnostic instrument to its present status as one of the most useful tools in medical diagnosis. Radiology touches on every phase of medicine. In hospital administrative circles it has become recognized as one of the principal sources of hospital income. It has come a long way from the days when some interested photographer, physicist, or physician rigged up a Crookes' tube to some wet cell batteries and a Rumpkoff coil and visualized a fracture. In these years of growth, radiology has become more and more dependent upon technical advances such as the Coolidge or hot cathode tube, the Potter-Bucky diaphragm, shock proof equipment, and rotating anode tubes. All of these items represent technical improvements in the equipment which have produced roentgenograms with better detail, even when made under difficult circumstances. Intensifying screens and safety films have also contributed considerably to the widespread use of radiology in medicine.

During all of these technical developments, there has been one bottleneck in the Radiology Department which has remained consistent from the beginning, and that is the darkroom. The time lag in film processing has been essentially the same since the days of Röntgen. Automatic film processing first became practical at about the end of World War II and marked a great step forward in the handling of films in large, busy departments. However, there was still at least a forty-five minute delay from the time of the film exposure until the dry processed film was available. In many cases the referring physician could not or would not wait to get the result of the examination. Consequently, there was developed the method of wet film reading and wet film handling.

A Radiology Department, like any busy installation, works best when it is kept on an assembly line basis, with each film handled in a smooth, orderly manner. Once a film is dealt with other than in the routine way, difficulties begin to develop which multiply as the number of films so handled increases. In our Institution with its high proportion of acute trauma and other emergency type patients, a great many of our films were constantly elsewhere in the hospital on film hangers and in a very sad state of preservation.

About five years ago several companies began work on methods of rapid automatic film processing. We were rather closely associated with the development of two of these units and eventually purchased the first type that became available commercially. It consists of many rollers that carry the films through the solutions and dryer, producing a dry processed film in less than six minutes.

Its installation has produced many changes in the operation of the Department. Its immediate accomplishments are quite obvious: *i.e.*, the elimination of film hangers, improved cleanliness of the floors because of no wet films, the absence of stains and spots on clothing, furniture and equipment, and also the improved morale of the personnel of the Department, which to us is a very important result.

A more subtle effect has been a marked improvement in the quality of the roent-

* Presented at the Sixtieth Annual Meeting of the American Roentgen Ray Society, Cincinnati, Ohio, September 22–25, 1959.

genograms, resulting from a complete lack of artifacts. The technicians have learned that the processing now is a constant factor and there is no reason for them not to get a good result except by some failure on their own part, such as use of the wrong kilovoltage, distance or position. In other words, they cannot blame poor quality roentgenograms on the darkroom, as was so frequently done in the past.

On the day the unit went into full operation we instituted a system whereby, before each examination, our file clerks give the patient's film jacket, with all previous roentgenograms, along with the requisition, to the technician. Immediately upon completion of the examination, the technician places the film jacket and the requisition on a table at the end of the processor where a second technician is assigned. (We call him "Tail-End Charley.") His task is to take the processed films as they come out of the machine, check them for technique, clip them to the film jacket and the requisition, and make them immediately available for reading. This method resulted in the elimination of our need for two additional file clerks, because now the films are sorted with the requisition and film jacket automatically by the technician. Previous to the installation of this unit, the increasing volume of work in our file room was almost completely beyond the capacity of our present personnel and I was actively campaigning for two additional file clerks. We were running at least twenty-four hours behind on the reading of films. Now the films are read and the report typed usually within an hour after the examination.

To summarize the above, the pressure point of the Department has now moved from the file room, which in my eleven years here had never been a satisfactory operation, to the professional staff of the Department. A physician must now always be in the Department because there is no reason for not reading a film as soon as it is processed. The absence of film hangers and wet films means that, if the film does get out of the Department before it is read, we usually have no way of knowing that fact when it is subsequently returned; therefore, each film should be read as soon as possible after it leaves the machine. Now films are read as they are processed rather than after they have accumulated into large stacks. With the elimination of the backlog, the pressure on the radiologist has been reduced considerably, and he now can interpret his roentgenograms in a more relaxed manner. The leveling off of the peaks of tense film reading has improved the temper of the staff considerably.

On the four afternoons a week when the Orthopedic Clinic is held on the floor below our Department we have from 30 to 75 patients sent to us from there. Most of their roentgenograms are seen by the Orthopedic Staff before they leave the hospital. Many of them need cast changes; some are diagnostic problems. We have always accomplished this in the past by sending the wet films down to the Orthopedic Clinic, which meant pools of water all over the floors, the elevators, etc. Also, a number of the films were stuck together when they were returned, or otherwise ruined by mishandling by the patients and others during their tour through the hospital. We have replaced this previous system with the following method, which is quite satisfactory: When the technician starts the roentgenographic examination she has the requisition and the previous film jacket on hand. After completing the examination, the exposed films are placed in the darkroom and the jacket and requisition are placed at the end of the machine as described above. The "Tail-End Charley" takes the newly processed films at the end of the machine and places them with the old envelope and requisition, which are then given to a radiologist sitting in the next room. He interprets the roentgenograms, dictating his report directly to a typist who is sitting by his side. The report is immediately signed by the radiologist and clipped to the outside of the film jacket, along with the most recent roentgenograms. The film jacket, the typewritten report, and the

new roentgenograms are then sent to the Orthopedic Clinic where the clerk removes the typewritten report, pastes it on the patient's chart, and presents the film jacket containing the old films with the new films clipped on the outside to the orthopedic surgeon. He views the films, reads the report, makes his decision, and then places them inside the jacket. This reduces the time of the handling of the films, provides the orthopedic surgeon with the radiologist's evaluation of the films and results in one less operation for the hospital record room (*i.e.*, the sorting out of two or three day old reports and pasting them on charts). At the same time it permits the physician to see a dry, well-processed film that is certainly an improvement over the streaked, wet, frequently wrinkled films so common in days gone by. We hope, as facilities become available in the future, to do more direct reading to typists, which will permit us to reduce the time of handling of the written reports considerably.

The use of this unit has permitted us to solve some of the problems of microfilming as well. We now have our microfilm camera at the end of the film processing unit and microfilm each roentgenogram just after cutting the film corners. We then have the microfilm processed as a negative only and file the rolls by dates. This gives us a permanent record of all the films that go through the Department so that, if they do get lost or misplaced later, we still have the copy. Only about 1 per cent or less of our films are called for after three years so that any labor expended is for the films that have real clinical or legal significance. This method requires no additional labor to do the microfilming and it represents a considerable saving in wages.

The initial cost of such a film processing unit is quite high, but the improved service to the patient and his referring physician should help to offset this by increased use of the Department. The chemicals' cost in comparable six month periods at this hospital showed that we spent 4 mills less per film developed with the automatic film processor than before its installation.

Everything seems to point to the fact that the machine is resulting in the referring physician using the radiologists more and more in the direct handling of his patients. This means that the radiologist is more truly a consultant, inasmuch as his findings are permanently available about as quickly as those of any consultant who might be asked to see the patient. In this respect we compare very favorably with the internist and his stethoscope now that the lag period of developing and drying has been reduced to a very convenient time.

One warning is appropriate to any radiologist who acquires this unit: one must be prepared to have professional coverage in his Department as long as the unit itself is working. The old excuse about waiting for the wet films to dry is no longer valid.

This rapid automatic film processing machine is one of the outstanding new developments in radiology. It represents a fundamental change in the operation of the Radiology Department, which is all to the good and makes the diagnostic radiologist now more of a physician than ever before.

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ICRP

REPORT ON DECISIONS AT THE 1959 MEETING OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

INTRODUCTION

THE period since the Commission's last regular meeting in 1956 has been the most active in its history. Because of rapid developments in the field of nuclear energy and the more widespread use of radiation sources of all types, the scope of the work has increased beyond the field of medical radiology into all fields of radiation protection, including industrial uses as well as the exposure of the general public.

In 1955 the United Nations established a Scientific Committee on the Effects of Atomic Radiation to collect and evaluate information on radiation exposure and radiation effects. In addition, bodies such as the World Health Organization, the International Labor Office, the Food and Agriculture Organization and the International Atomic Energy Agency are actively interested in radiation protection problems and look to the International Commission on Radiological Protection for guidance. Although the primary responsibility of the Commission has been to the radiological profession, it has had to widen its scope and has accordingly been active not only during the last two international Congresses of Radiology but also in the intervening period.

Amendments to the 1953[1] Recommendations were reported to the Mexico Congress and published in 1957.[2] Revised Recommendations of the Main Commission were adopted in 1958 and printed early in 1959.[3] Reports of the various Committees exist at present in various stages of preparation. The Report of Committee II on internal radioactive substances is already in press.[4] A revised version of the Committee III Report, which is essentially a code of practice for the radiological profession, was approved during the 1959 meeting and will be published in the near future.[5] The Report of Committee IV on high energy and heavy particle radiation is undergoing a final revision. Committee V has prepared a report on the disposal of radioactive waste from hospitals and laboratories and is proceeding as rapidly as possible to prepare a further report on the disposal of waste from atomic energy establishments.

The Commission has an official relationship with the World Health Organization and the International Atomic Energy Agency. There has been close cooperation with the United Nations Scientific Committee on the Effects of Atomic Radiation, and the Commission, jointly with the International Commission on Radiological Units and Measurements, has on two occasions accepted its invitation to perform special studies. The results of the first study on the evaluation of gonad dose from medical procedures were published in 1957.[6] The second study, on the evaluation of exposure relevant to somatic damage, has been initiated and a report is to be prepared before the end of 1960.

The Commission also cooperates with the International Labor Office and the Food and Agriculture Organization and has invited them to send observers to future meetings. The Commission has been invited to send observers to appropriate meetings of the International Organization for Standardization and the United Nations Educational, Scientific and Cultural Organization.

During the 1959 meeting, the Commission discussed its basic Recommendations[3] and, although no substantial changes were made, a number of explanatory statements were drafted. These statements which will be presented in the following text include such subjects as the irradiation of pregnant women, the maximum doses to individuals in the population at large, the interpretation to be placed on the paragraph dealing with the contamination of public air and

water supplies, and the hours of work and vacation of radiation workers.

A grant from the Rockefeller Foundation made it possible for the Commission to invite a number of non-member experts on dose-effect relations to participate in the Munich discussions and be available for consultation.

During the preparation of this statement the ICRP has had the following composition:

1956–1959

(including the Munich sessions)

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R. S. Stone (U.S.A.)
L. S. Taylor (U.S.A.)
E. A. Watkinson (Canada)
Sir Ernest Rock Carling, Chairman Emeritus (Great Britain)

1959–

(present composition)

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B. Lindell, Secretary (Sweden)
W. Binks (Great Britain)
L. Bugnard (France)
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L. S. Taylor (U.S.A.)
E. A. Watkinson (Canada)
Sir Ernest Rock Carling, Chairman Emeritus (Great Britain)
G. Failla, Vice-Chairman Emeritus (U.S.A.)

* Mr. Binks resigned as Secretary in 1957, for health reasons. After his resignation E. E. Smith (Great Britain) served as Acting Secretary, and since August 1, 1957, B. Lindell (Sweden) has served as Temporary Secretary.

EXPLANATORY STATEMENTS AND AMENDMENTS TO THE 1958 RECOMMENDATIONS

In the 1958[3] Recommendations all maximum permissible doses are expressed in rems without reference to the appropriate RBE values. Such reference will be given in the reports of the Committees concerning the application of the recommendations in various specified fields. The RBE values used in each of the Committee reports to be published are consistent with those published in 1954.[1]

The following statements refer to particular paragraphs in the 1958 Recommendations:

EXPLANATORY STATEMENT OF PARAGRAPH 46 (SEE ALSO PARAGRAPHS 35 AND 41)

It has been recommended that "medical exposure" be excluded from the calculation of the maximum permissible dose of those occupationally exposed. The Commission wishes to emphasize that "medical exposure" refers to the exposure of *patients* that is necessary for medical purposes and *not* to the exposure of the personnel conducting such procedure.

INTERPRETATION OF PARAGRAPH 49 (SEE ALSO PARAGRAPHS 10, 14 AND 52)

A calendar 13 week period may be used instead of a period of 13 consecutive weeks *if there is no reason to suppose that doses are being accumulated at grossly irregular rates.*

ADDITION TO PARAGRAPH 49

The following words should be added at the end of the paragraph—"*especially in the case of women of reproductive age.*"

NEW PARAGRAPH TO BE ADDED AFTER PARAGRAPH 51 (E)

"51 (f) Where work involves exposure to β-rays of $E_{max} > 2.5$ mev., eye shields or other suitable shielding may be necessary to keep the dose in the lens within permissible limits. In the case of exposure to β-rays of lower energy, if the provision of such shielding is impracticable, the small additional β-ray dose in the lens over the dose already permitted for more penetrating

radiations, such as γ-rays or neutrons, is permissible, provided the dose in the skin is limited to the level recommended in paragraph 52 (a)."

ADDITIONAL PARAGRAPHS REGARDING THE APPLICATION OF PARAGRAPHS 49, 51 (D) AND 51 (E) TO CASES OF INTERNAL EXPOSURE

With reference to paragraph 49:

"52 (e) One or more short term exposures to radioactive materials (together with any exposure to external radiation) within a period of 13 consecutive weeks is considered acceptable if the total intake of radioactive material during this period does not exceed the amount that would result from intake for 13 weeks at the maximum levels for occupational exposure to such radioactive materials permitted by the 1959 Report of Committee II. The dose to the critical organ during the following 50 years resulting from such an intake will not exceed the quarterly limit on dose stated in the 1958 Recommendations of ICRP. These limits are:

(1) for the whole body and the gonads: 3 rems,

(2) for the skin, thyroid and bone*: 8 rems,

(3) for other organs: 4 rems."

With reference to paragraph 51 (d):

"52 (f) In the case of an accidental high exposure to radioactive materials where the total intake of radioactive material exceeds the amount that would result from intake for one year at the maximum levels for occupational exposure to such radioactive materials permitted by the 1959 Report of Committee II, an estimate of the intake resulting from the exposure shall be entered on the individual's record and he shall be referred to competent medical authorities for appropriate action."

With reference to paragraph 51 (e):

"52 (g) Emergency work involving exposure above permissible limits to radioactive materials shall be planned on the basis that the total intake of radioactive material during the emergency period should not exceed the amount that would result from intake for one year at the maximum levels for occupational exposure to such radioactive materials permitted by the 1959 Report of Committee II. The dose to the critical organ during the following 50 years resulting from such an intake will not exceed the maximum yearly limit on dose stated in the 1958 Recommendations of ICRP. These limits are:

(1) for the whole body and the gonads: 12 rems,

(2) for the skin thyroid and bone*: 30 rems,

(3) for other organs: 15 rems.

When such an exposure has occurred, an estimate of the intake shall be entered in the individual's record and measures shall be taken to prevent further exposure during the period of time it would take to accumulate this intake at the constant level of occupational exposure permitted by the 1959 Report of Committee II for such materials."

EXPLANATORY STATEMENT OF PARAGRAPHS 53 TO 57 (SEE ALSO PARAGRAPHS 15, 16, 38 AND 39)

The size of a "group" or a "population" is a relative concept and it is often difficult to decide whether a group should be considered "large" and whether relatively small national populations should be referred to as the "whole" population with respect to exposures of which the importance depends on the size of the group exposed. The size of a group is irrelevant in the case of *individual* exposure, where groups are defined only to distinguish between individuals for whom the recommended maximum permissible doses are different for various reasons or for whom the membership of a certain group provides for more specific recommendations with regard to individual monitoring, medical examinations and surveys of the protection conditions. In the case of e.g. average exposure, however, the "*whole*" *population* is involved and the responsibility for the interpretation of this concept will rest with

* Based on body burden of 0.1 microcurie of Ra^{226} (see Report of Committee II).

national and international administrative authorities responsible for the legal application of protection requirements.

ADDITIONAL SECTION REGARDING EXPOSURE OF INDIVIDUAL MEMBERS OF THE POPULATION AT LARGE (TO FOLLOW AFTER PARAGRAPH 57)

A new section, under the heading "Exposure of the Population at Large" should be added after the section headed "Exposure of Special Groups" (paragraphs 53–57). The text to be added, referring to both external and internal exposure, reads: "The maximum total dose limit for *individuals* in the population at large (excluding those occupationally exposed and the special groups B (a) and B (b)) should be that recommended for members of the special group B (c) (cf. paragraph 55)."

CORRECTION TO PARAGRAPH 65

Paragraph 65: The figure "1.7" in paragraph 65 Addendum (c) is a misprint for "0.7."

INTERPRETATION OF PARAGRAPH 68

The basis for the limits of permissible exposure of populations to man-made sources of ionizing radiations is the dose received by the various organs of the body and not the MPC-values, or other criteria by which the dose is controlled. Nevertheless, for planning purposes some guidance as given in paragraph 68 must be available. The word "average" in paragraph 68 refers to the concentration of radioactive nuclides, averaged over a year, in the total intake to the average person of the population.

STATEMENTS ON ITEMS NOT INCLUDED IN THE 1958 RECOMMENDATIONS

OCCUPATIONAL EXPOSURE OF PREGNANT WOMEN

With regard to occupational exposure of pregnant women the Commission notes that:

1. It is especially in respect of somatic damage in fetal tissues that pregnant women present a "special risk problem" in case of occupational exposure.
2. Any special recommendations for pregnant women must in practice apply to all women of reproductive age.

OCCUPATIONAL WORKING HOURS AND LENGTH OF VACATION

The Commission considers that with the present maximum permissible exposure levels no special treatment of radiation workers with respect to working hours and length of vacation is required.

EMERGENCY EXPOSURE OF ENVIRONMENTAL POPULATIONS

This subject was discussed extensively during the Munich meetings and the Commission considers that the British Report[7] recommending criteria for acceptable levels under emergency conditions of I^{131}, Sr^{89}, Sr^{90} and Cs^{137} ingested in food or milk constitutes a useful and sound approach to the subject.

REFERENCES

1. Recommendations of the International Commission on Radiological Protection (revised Dec. 1, 1954). *Brit. J. Radiol.*, 1955, Suppl. No. 6.
2. Report on amendments during 1956 to the Recommendations of the International Commission on Radiological Protection. *Acta radiol.*, 1957, *48*, 493–495; *Radiology*, 1958, *70*, 261–262; *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, 1958, *88*, 500–502.
3. Recommendations of the International Commission on Radiological Protection (adopted Sept. 9, 1958). ICRP Publication 1, Pergamon Press, London, 1959.
4. Report of Committee II on permissible dose from internal radiation (1959). ICRP Publication 2, Pergamon Press, London (in press).
5. Report of Committee III on protection against x-rays up to energies of 3 MeV and β- and γ-rays from sealed sources (1959). ICRP Publication 3, Pergamon Press, London (in press).
6. Exposure of man to ionizing radiation arising from medical procedures; a report of the International Commission on Radiological Protection and International Commission on Radiological Units and Measurements. *Physics in Med. & Biol.*, 1957, *2*, 107–151.
7. Report to the Medical Research Council by its Committee on protection against ionizing radiations (Chairman: E. E. Pochin). Maximum permissible dietary contamination after the accidental release of radioactive material from a nuclear reactor. *Brit. M. J.*, 1959, *1*, 967–969.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Electrical Impedance Plethysmography; the Electrical Resistive Measure of the Blood Pulse Volume, Peripheral and Central Blood Flow. By Jan Nyboer, D.Sc., M.D., Chief, Division Cardiovascular Physiology Research, Electrocardiographer and Associate Physician, Department of Medicine, Harper Hospital, Detroit, Michigan; Professor, Department of Physiology and Pharmacology, Wayne State University Medical School, Detroit, Michigan. Publication Number 362, American Lecture Series; a Monograph in the Bannerstone Division of American Lectures in Medical Physics. Edited by Otto Glasser, Ph.D., Cleveland Clinic Foundation, Cleveland, Ohio. Cloth. Price, $7.50. Pp. 243, with 104 illustrations. Charles C Thomas, Publisher, 301-327 East Lawrence Avenue, Springfield, Ill., 1959.

The impedance plethysmograph determines changes in the volume of blood in tissues by measurements of the changes in resistance during the cardiac cycle. The conversion of changes in resistance to blood flow is based on Ohm's law and that of parallel resistance. The author assumes that the volume resistivity of blood is dependable as a factor in the equation for the volume of a conductor.

Its chief advantage appears to be its simplicity in clinical application where it can be used to detect changes in pulse volume, hindrances and flow in the limbs in peripheral vascular disease. Using leads across the precordium it can also be used to record changes in cardiac volume with systole and diastole, records of which are very much like those of the electrokymograph.

For those contemplating the use of this instrument, Dr. Nyboer has performed a useful service in describing the equipment and its applications. The book is in three parts. The first describes the theoretic basis of the method and compares the impedance with the mechanical pulse volume. The second supplies the practical details of the impedance measurement and the third part gives a full account of the many diverse applications of the method in physiologic and clinical practice. There is a final section on the application to measurement of flow by the dilution method utilizing changes in conductivity of blood after injections of saline solutions.

The author points out that Stewart's method used in this manner is a direct measure of flow similar to the Fick method. I personally obtained a number of good ideas from this monograph, which serve my interest in vascular phenomena.

James Conway, M.D., Ph.D.

Atlas of Tumor Pathology. Section VII—Fascicles 27 and 28. Tumors of the Pancreas. By Virginia Kneeland Frantz, M.D., Professor of Surgery, College of Physicians & Surgeons, Columbia University; Attending Surgical Pathologist, Presbyterian Hospital, New York, New York. Paper. Price, $1.50. Pp. 149, with 94 illustrations. Armed Forces Institute of Pathology, under the auspices of the Subcommittee on Oncology of the Committee on Pathology of the Division of Medical Sciences of the National Academy of Sciences, National Research Council, Washington, D. C., 1959. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C.

These fascicles contain a comprehensive discussion not only of tumors of the pancreas but of other conditions simulating them. They contain more text than some of their predecessors in the *Atlas of Tumor Pathology* and gain proportionately in value. As usual, the numerous reproductions are beyond reproach. There is an extensive review of the literature and many of the statistics are based on publications other than the author's.

The importance of a biopsy in making a diagnosis in pancreatic lesions is stressed and the surgical complications of this procedure are outlined, but the difficulties in distinguishing carcinoma from inflammatory diseases on fresh frozen sections are perhaps not emphasized sufficiently. The section on tumors of islet tissue reflects the experience of the author with these lesions. In common with neoplasms of

many endocrine glands, it is impossible to distinguish malignant from benign tumors, except in the presence of metastases. Islet cell adenomas are not infrequently multiple and, as a result, removal of one obvious tumor may not relieve symptoms of spontaneous hypoglycemia. There is a complete discussion of peptic ulceration associated with nonfunctioning islet cell adenomas and with adenomas of multiple endocrine glands. Finally, the literature on cases of extrapancreatic tumors associated with hypoglycemia is reviewed and the 20 cases reported to date are summarized in table form.

These fascicles will be a most valuable addition to the library of pathologists, surgeons, gastroenterologists and endocrinologists.

Andrew R. W. Climie, M.D.

Annual Review of Medicine. Volume 10. Edited by David A. Rytand, M.D., Stanford University School of Medicine; and Associate Editor William P. Creger, M.D., Stanford University School of Medicine. Cloth. Price, $7.00. Pp. 448. Annual Reviews, Inc., Grant Avenue, Palo Alto, Calif., 1959.

As in the preceding volumes of this series, reviews of selected medical subjects are presented. Cardiovascular diseases are well covered in sections dealing with cardiovascular diseases generally, atherosclerosis and the surgical approach to cardiovascular disease. The general discussion of cardiovascular disease is enhanced by frequent insertion of the reviewer's opinions and criticisms of the work described.

The section entitled "Special Therapeutics (Transfusions)" is required reading for any physician who considers ordering a blood transfusion. The reviewer has emphasized some important considerations in transfusion therapy which are frequently overlooked.

The two sections on cancer are timely and well done. One discusses the advances which have been made in the investigation of experimental tumors and the etiology of neoplasia. The second deals extensively with chemotherapy.

The individual reviews are excellent. A valuable feature of this volume is the lists of references which follow each section.

Ronald C. Bishop, M.D.

The Mast Cells. By James F. Riley, M.B., Ch.B. (Hons.), M.D., Ph.D., D.M.R.T., F.R.C.S.E., Consultant Radiotherapist, Royal Infirmary, Dundee; Lecturer in Radiotherapy, University of St. Andrews. Cloth. Price, $6.75. Pp. 182, with 65 illustrations. E. & S. Livingstone, Ltd., Edinburgh, and Williams & Wilkins Co., Mount Royal and Guilford Avenues, Baltimore, Md., 1959.

The study of the nature and function of tissue mast cells proceeded slowly for the first fifty-eight years following their original description by Ehrlich. In 1937 the first major contribution was made when Scandinavian workers demonstrated that mast cells contain heparin. The second finding of great significance was made by the author of this monograph in 1953 when he published work demonstrating that, in addition to heparin, mast cells contain histamine.

Part I of this book introduces the reader to the subject by tracing the evolution of the mast cell in various species, discussing its relation to the circulating basophil and to the production of heparin.

Part II describes the author's experimental work, which leaves little room for doubting that mast cells are the primary source of histamine. Perhaps the most convincing studies are those demonstrating a direct relationship between the assay of histamine in a tissue and its content of mast cells. Confirmatory evidence is obtained by depleting tissues of histamine by the use of specific chemicals, the tissues affected then being shown to be devoid of mast cells.

The book is clearly written and contains a very extensive bibliography. It is a major contribution to the literature on this subject.

Andrew R. W. Climie, M.D.

Modern Trends in Diseases of the Vertebral Column. Edited by Reginald Nassim, B.M., F.R.C.P., Physician to St. George's Hospital, Physician to the Royal National Orthopaedic Hospital, London; and H. Jackson Burrows, M.D., F.R.C.S., F.R.A.C.S., Orthopaedic Surgeon to St. Bartholomew's Hospital, and to the Royal Institute of Orthopaedics, British Postgraduate Medical Federation (University of London), Consulting Orthopaedic Surgeon to the Royal Navy. Cloth. Price, $15.00. Pp. 292, with 172 illustrations. Paul B. Hoeber, Inc., 49 East 33rd Street, New York 16, N. Y., 1959.

This book deals with the vertebral column in great detail. The development and anatomy of

the spine, congenital anomalies, degenerative changes, dieseases which may affect the spine and metabolic influences are thoroughly covered. Other chapters deal with tumors, radiology, spinal cord injuries and low back pain of both organic and psychosomatic origin. The place of needle biopsy for diagnosis is discussed, and the sections on scoliosis and ankylosing spondylitis are particularly well done. Your reviewer, being an orthopedic surgeon, was disappointed with the chapter on low back pain. The conservative management of this problem was barely mentioned aside from manipulation, which is not widely practiced in this country.

The subject is handled in the broadest sense, with orthopedic surgeons numbering five of the fifteen contributors. Each is an expert in his field. The book is well illustrated, documented and indexed, and is easy to read and handle. It is a very up to date survey of all of the phases of identification and treatment of the diseases of the vertebral column. It can be recommended without qualification for the library of those managing problems of the vertebral column.

Frank P. Walsh, M.D.

BOOKS RECEIVED

Radiologic Examination of the Small Intestine. Second edition. By Ross Golden, M.D., D.Sc., Visiting Professor of Radiology, University of California at Los Angeles; Professor Emeritus of Radiology, Columbia University; Formerly, Director of Radiology, The Columbia-Presbyterian Medical Center, New York City. Cloth. Price, $28.50. Pp. 560, with 176 illustrations. Charles C Thomas, Publisher, 301–327 East Lawrence Avenue, Springfield, Ill., 1959.

Electrical Impedance Plethysmography; the Electrical Resistive Measure of the Blood Pulse Volume, Peripheral and Central Blood Flow. Publication Number 362, American Lecture Series; a Monograph in the Bannerstone Division of American Lectures in Medical Physics. By Jan Nyboer, D.Sc., M.D., Chief, Division Cardiovascular Physiology Research, Electrocardiographer and Associate Physician, Department of Medicine, Harper Hospital, Detroit, Michigan; Professor, Department of Physiology and Pharmacology, Wayne State University Medical School, Detroit, Michigan. Edited by Otto Glasser, Ph.D., Cleveland Clinic Foundation, Cleveland, Ohio. Cloth. Price, $7.50. Pp. 243, with 104 illustrations. Charles C Thomas, Publisher, 301–327 East Lawrence Avenue, Springfield, Ill., 1959.

Soil, Grass and Cancer: Health of Animals and Men is Linked to the Mineral Balance of the Soil. By André Voisin, Membre de l'Académie d'Agriculture de France; Chargé d'Enseignement à l'École Nationale; Vétérinaire d'Alfort (Paris). Translated from the French by Catherine T. M. Herriot and Dr. Henry Kennedy. Cloth. Price, $15.00. Pp. 302, with 17 illustrations. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., 1959.

Chemistry of Nuclear Power. By J. K. Dawson, Ph.D., F.R.I.C., Senior Principal Scientist, Reactor Chemistry Group, A.E.R.E., Harwell, England; and G. Long, Ph.D., A.R.I.C., Reactor Chemistry Group, A.E.R.E., Harwell, England. Cloth. Price, $6.00. Pp. 208, with 36 illustrations and 29 tables. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., 1959.

Radiology; Cumulative Index (iv); Volumes 60–69, 1953–1957. Cloth. Pp. 398. Radiological Society of North America, Inc., 713 East Genesee Street, Syracuse 2, N. Y., 1959.

Oak Ridge Institute of Nuclear Studies; Thirteenth Annual Report for the Year Ending June 30, 1959. Paper. Pp. 76. Oak Ridge Institute of Nuclear Studies, Inc., Post Office Box 117, Oak Ridge, Tenn.

The Scandinavian Journal of Clinical & Laboratory Investigation. Vol. xi—Supplementum 40. A Study in Right Heart Performance in Man with Special Reference to the Effect of Experimentally Induced Acute Hypervolemia. By Bengt Thomasson. Paper. Pp. 76. Sahlgrenska Sjukhuset University of Göteborg, Sweden, 1959.

The Scandinavian Journal of Clinical & Laboratory Ivestigation. Vol. xi—Supplementum 41. Relations of Renal Tubular and Glomerular Function as Influenced by 75 Per Cent Reduction of Nephron Number; A Patho-Physiological Study. By Andreas Kolberg. Paper. Pp. 152. Oslo University Press, Oslo, Norway, 1959.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Chest

Torrance, Daniel J., Jr. Roentgenographic signs of pulmonary artery occlusion. *Am. J. M. Sc.*, May, 1959, *237*, 651–662. (From: Johns Hopkins University School of Medicine, Baltimore, Md.)

The frequency of pulmonary embolism and infarction discovered at necropsy is matched by the surprisingly frequent failure to recognize the characteristic roentgenographic signs, which, either alone or in combination, should suggest the diagnosis. Review of roentgenograms of many necropsy-proved cases and clinically-proved cases reveals a preponderance of such diagnoses as pneumonia, postoperative pneumonia, postoperative pneumonitis, postoperative atelectasis, aspiration pneumonia or pneumonitis and such noncommittal readings as nonspecific infiltration, basal infiltrate, and others.

The chest roentgenogram shows: (1) no demonstrable abnormality; (2) pleural effusion or reaction as the only sign; (3) focal parenchymal density, with or without pleural reaction; (4) pneumothorax; (5) changes in the peripheral vascular shadows; (6) changes in the cardiac contours; and (7) elevation of the diaphragm.

The distinction between pulmonary artery occlusion without infarction and occlusion with infarction is emphasized.

When there is occlusion of a pulmonary artery, the chest roentgenogram shows one of the following:

(1) No change. This is by far the most frequent occurrence.

(2) Pleural reaction or effusion as the only roentgenographic sign. A rare manifestation of pulmonary infarction is the development of empyema or infected pleural effusion.

(3) Focal parenchymal density (one or more), with or without pleural reaction. If there is no pleural reaction, the roentgenogram of the chest shows a density which may consist entirely of atelectasis (manifested by streaking on the roentgenogram). The atelectatic nature of these transient streaks in the lung fields has long been understood, as evidenced by the terms "platter atelectasis" and "discoid atelectasis." Investigation at necropsy reveals only a layer of collapsed lung to explain the density. The linear shadows are usually evanescent, as one would expect of atelectasis.

The frequency of this "platter atelectasis" with pulmonary artery occlusion and its rarity with infectious lesions of the lung make its presence very helpful in the roentgenographic diagnosis of pulmonary embolism or infarction. The streaking is generally horizontal in the lower lung fields.

A review of over 100 cases of necropsy-proved pulmonary infarction revealed localization in the right lower lobe in 70 per cent of the cases. Investigation of the localization of emboli in the same series showed no such selectivity, there being a more-or-less random distribution. Thus the right lower lobe localization appears to be well established, although the mechanism of it is not.

It is important to emphasize that only about 10 per cent of the pulmonary infarcts have the characteristic wedge-shape described so frequently. When the so-called wedge density is seen, however, it is of great diagnostic importance. Here again, the peripheral localization of the density is helpful in establishing the diagnosis. If a pulmonary lesion is central and on no projection extends to the pleural surfaces, it is not a pulmonary infarct.

(4) Pneumothorax. This is seen as a rare manifestation of pulmonary infarct. This was encountered as a proved instance in the present series.

(5) Changes in the peripheral vascular shadows. Changes in the peripheral vascular shadows frequently are an accompaniment of pulmonary embolism, with or without pulmonary infarction. Changes of this nature are seldom recognized in many cases of pulmonary embolism. As a rule, embolism must involve a large vessel, probably a lobar vessel or larger, in order to cause roentgenographically demonstrable changes in vessel caliber.

(6) Changes in cardiac contour. Changes in the cardiac contour are those of acute and chronic cor pulmonale. In some cases of cor pulmonale, cardiac compensation occurs through hypertrophy alone; and in others chiefly by dilatation, making for further difficulties in the diagnosis of right ventricular enlargement and hypertrophy. In all cases of *massive, severe pulmonary embolism*, however, both elements are present in the resulting chronic cor pulmonale.

(7) Elevation of the diaphragm. Diaphragmatic elevation occurs frequently in pulmonary embolism alone and even more frequently with infarction. The reason for this elevation with embolism alone is unknown. A high diaphragm is not seen with a small embolism, without infarction, but only with massive embolization.—*Stephen N. Tager, M.D.*

Fisher, J. M., and Van Epps, E. F. (Iowa City, Iowa.) Aplasia or hypoplasia of one pulmonary artery: radiologic and pulmonary function studies. *Am. Heart J.*, July, 1959, *58*, 26–40.

Seven cases of aplasia or hypoplasia of one pulmonary artery are reported.

Physical findings include asymmetry of the thorax, diminished expansion and decreased breath sounds on the affected side, hyper-resonance over the affected side, and sometimes a systolic murmur along the left sternal border or at the cardiac apex. The murmur is presumably from dilatation, distortion, and tortuosity of the other pulmonary artery.

Symptoms of cough, shortness of breath, hemoptysis and recurrent pulmonary infection are common.

Roentgen findings show thoracic asymmetry, high diaphragm and decreased expansion on the affected side, and a difference in the vascularity of the lung fields. It was concluded that angiocardiography should be reserved for patients with associated lung disease, such as bronchiectasis, which obscures the pulmonary vessels.

Pulmonary function studies reveal normal or slightly decreased vital capacity, maximum breathing capacity, and residual volume. Hyperventilation at rest was common.

Agenesis of a pulmonary artery may be associated with complete absence of the lung but, more commonly, is associated with hypoplasia. Hypoplasia of a pulmonary artery is, in the authors' experience, always associated with a maldevelopment of the lung. The extent of the anomaly varies considerably. When the left pulmonary artery is absent, there is frequently an associated cardiovascular anomaly.—*Charles H. Helmen, M.D.*

DERRA, E., LOOGEN, F., and VIETEN, H. Schwierigkeiten der Röntgendiagnostik raumfordernder Prozesse der Vorhöfe des Herzens. (Difficulties of the roentgen diagnosis of space occupying lesions of the atria of the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, March, 1959, *90*, 308–313. (From: Chirurgische Klinik, I. Medizinische Klinik, sowie Institut und Klinik für Medizinische Strahlenkunde der Medizinischen Akademie Düsseldorf, Düsseldorf, Germany.)

The diagnosis of intracardial space occupying lesions is difficult and, even today with the newest methods, sometimes impossible. The diagnosis is important since 35 per cent of all reported cases with a true intracardial tumor died of closure of the mitral ostium. Some of these tumors can be removed by surgery. Preoperatively, it is unimportant whether the space occupying lesion is an intracavitary tumor, a thrombus or a pseudotumor, *e.g.*, an echinococcus cyst. Of far greater significance is the localization and the origin of the mass, since the surgical possibilities depend on these findings. The authors describe the different intracardial tumors and their predominant locations. Heart thrombi are found mostly in the atria, especially in the left one.

The clinical symptomatology depends upon the site and the size of the tumors or thrombi. As long as they do not disturb the blood circulation, they are asymptomatic. If they grow into the veins, they cause a precardial inflow obstruction. More often the blood flow into the ventricle is obstructed and the clinical picture of a mitral or a tricuspid valvular lesion is simulated, on auscultation as well as on roentgen examination.

For differential diagnosis, the fast development of the clinical picture and the sudden change of the clinical signs and symptoms are characteristic. Periods of relative well-being are interrupted by crisis-like incidents. The most important clinical symptom is the change of the findings on auscultation when the patient changes his position. A mitral stenosis or insufficiency murmur, which disappears in the supine position of the patient, is diagnostic of a tumor of the left atrium. It is characteristic of a tumor of the right atrium if the tumor simulates a lesion of the bicuspid valve. Roentgen examination, including kymography and laminagraphy, fails to provide typical findings. The authors describe in detail the case of a forty-three year old patient. The roentgenogram revealed a calcified mass within the heart shadow. Venous catheterization of the heart suggested a space occupying tumor of the right ventricle, causing stenosis and insufficiency of the tricuspid ostium. Two illustrations show the roentgen findings.

A tumor of the left atrium may be suspected when there are changes of the blood pressure on change of position of the patient, presumably caused by the simultaneous change in position of the tumor. Angiocardiography may be helpful in diagnosis of space-occupying masses of the right heart, as in the case reported. The method is not reliable in the diagnosis of a mass of the left atrium, if the contrast medium is injected into a peripheral vein.

To summarize, intracardial space occupying lesions (blastomata, thrombi) of the right atrium give less diagnostic difficulties than the much more common lesions of the left atrium, which usually simulate mitral stenosis. Nevertheless, both history and clinical findings may provide clues for a space occupying lesion. Roentgen diagnosis is difficult. Even intravenous angiocardiography is generally unsuccessful if the lesion is situated in the left heart.—*Hans Lewin, M.D.*

CRYMES, THOMAS P., FISH, ROBERT G., SMITH, DANIEL E., and TAKARO, TIMOTHY. Complications of transbronchial left atrial puncture. *Am. Heart J.*, July, 1959, *58*, 46–52. (From: The Cardiopulmonary Laboratory, Veterans Administration Hospital, Oteen, N. C.)

Transbronchial left atrial puncture was performed on 86 patients. The left atrium was entered in all but one case in which the ascending aorta was punctured. It was impossible to pass the catheter into the left ventricle in 18 cases.

Three complications were noted. A polyethylene tube became knotted in the left atrium and had to be surgically removed. A second patient developed acute cardiac tamponade one hour following an uneventful left and right heart catheterization. The pericardial cavity was aspirated two times and the patient made an uneventful recovery. A third patient died eighteen hours following a left heart catheterization. It was presumed that the cause of death was

due to cerebral embolism secondary to dislodgement of a clot from the left atrium.

The authors reviewed the literature and report this to be the only death among 1,472 collected cases of transbronchial left atrial puncture, a mortality rate of 0.068 per cent. This is compared to 2,178 collected cases of paravertebral left atrial puncture with 15 deaths and a mortality rate of 0.69 per cent.

The authors conclude that the high rate of successful left atrial punctures, combined with the low overall morbidity and mortality, makes the transbronchial method the preferable technique for left atrial puncture.—*Eugene C. Klatte, M.D.*

Grosse-Brockhoff, F., Löhr, H. H., Loogen, F., and Vieten, H. Die Punktion des linken Ventrikels zur Kontrastmitteldarstellung seiner Abflussbahn. (Puncture of the left ventricle for contrast visualization of its outflow tract.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, March, 1959, *90*, 300–308. (From: I. Medizinische Klinik sowie Institut und Klinik für Medizinische Strahlenkunde der Medizinischen Akademie Düsseldorf, Düsseldorf, Germany.)

For roentgen visualization of the heart and great vessels, a contrast medium is injected, intravenously or intra-arterially. Neither of these methods provides a satisfactory contrast visualization of the outflow tract of the left ventricle.

Three special methods have been tried for the demonstration of this tract: (1) the direct percutaneous puncture of the left atrium, which furnishes satisfactory pressure measurements, but fails to produce good contrast visualization of the left ventricle and of its outflow tract, especially in the presence of mitral valvular disease; (2) the retrograde introduction of a catheter into the left ventricle through the aortic valve, via the carotid artery and the ascending aorta, which has been shown to be very satisfactory for blood pressure measurements as well as contrast visualization; and (3) the direct injection of the contrast medium by means of percutaneous puncture of the left ventricle.

The authors used this latter method in 26 cases. They injected the contrast medium following the pressure measurements. The technique of the injection of the contrast medium, 76 per cent urografin (Schering), is described in detail. Harmful side effects of this method have been described in the literature. The authors mention 1 case of air embolism with subsequent ventricular fibrillation, but this developed due to a technical disturbance. Besides this instance, which cannot be attributed to the method, the authors observed only insignificant irregularities of the heart rhythm. Only a small amount of blood extravasations was found later at operation.

The authors recommend the following precautions against accidents: (1) general endotracheal anesthesia; (2) the short beveled needle, securely fixed, must lie freely in the left ventricle; (3) injection must be performed in complete respiratory standstill; and (4) the electrocardiogram has to be registered continuously during, and a few minutes after, the injection.

Of the 26 cases with 23 contrast visualizations, 24 cases of aortic valvular disease were examined, 22 of them being cases of aortic stenosis. To demonstrate the diagnostic possibilities of the method, the authors describe 3 of their cases, 2 with aortic stenosis and 1 with a partial aortic arch syndrome, which was caused by a stenosis of the subclavian artery.

The authors believe that the method of injection of a contrast medium into the left ventricle by percutaneous puncture is indicated in aortic stenosis or combined aortic valvular disease, in possible cases of aortic arch syndrome, in questionable ventricular septal defect, and in aortic aneurysms close to the heart.—*Hans Lewin, M.D.*

Steinberg, Israel. Angiocardiography in diagnosis of congenital heart disease in infancy and childhood. *J.A.M.A.*, June 13, 1959, *170*, 772–780. (Address: 170 E. 77th St., New York, N. Y.)

Intravenous angiocardiography is reviewed in detail with respect to the types of material needed and the roentgenographic technique required for a satisfactory examination. A comparison of the risks involved in selective angiocardiography and intravenous angiocardiography has been made. The author has only had one fatality during the procedure in more than 1,500 infants and children.

Congenital cardiac lesions have been grouped anatomically depending upon whether there is: (1) stenosis of a valve or vessel, (2) cardiac and great vessels shunts, (3) complex malformation (tetralogy of Fallot and transposition of great vessels), or (4) great vessel anomalies.

(1) *Stenosis of a vessel or valve.* The procedure has been of great value in this group which includes pulmonary stenosis, aortic stenosis, congenital mitral stenosis, and coarctation of the aorta. Considerable detail may be obtained regarding the size and configuration of valve cusps and adjacent structures. In aortic stenosis, it is almost impossible to distinguish between valvular and subvalvular types.

(2) *Simple shunts.* This group includes atrial septal defects, ventricular septal defects, patent ductus arteriosus and aortic septal defects. The angiocardiograms prove less valuable in this group of lesions for, in many instances, the diagnosis is made by the identification of reintensification of a chamber. In small shunts the procedure is of little value, while the larger shunts may demonstrate reopacification of a chamber. Other techniques must be used to differentiate patent ductus arteriosus and aortic septal defects.

(3) *Complex malformations.* This group includes

tetralogy of Fallot, the Eisenmenger complex, transposition of the great blood vessels, Taussig-Bing syndrome and tricuspid atresia. Angiocardiography is very useful in the study of the tetralogy of Fallot. It demonstrates associated anomalies of the aortic arch and its branches, and may often be a determining factor in the type of aorticopulmonary operation performed. The method is frequently of little aid in making a diagnosis of the Eisenmenger complex. Transposition of the great blood vessels occurs in varying degrees and angiocardiography may be of little help in differentiating the origin of the aorta and pulmonary vessels. Tricuspid atresia may frequently be well observed and outlined by the use of this method.

(4) *Anomalies of the large arterial vessels.* This group includes the pulmonary artery, aorta and pulmonary veins. Angiocardiography readily demonstrates enlargement of the pulmonary artery but produces little information in regard to etiology. Anatomic abnormalities may be readily demonstrated. Aortic aneurysms in an unruptured state may be diagnosed by this method. In general, study of the pulmonary veins requires cardiac catheterization as well as angiocardiography for full evaluation.

Angiocardiography is not indicated in every case of congenital heart disease because the physical, electrocardiographic, and conventional roentgenographic examinations usually provide a high degree of accuracy in the diagnosis of cardiovascular disease. Furthermore, the complex types of congenital heart disease may be difficult to diagnose even after angiocardiography and cardiac catheterization. However, considerable diagnostic data are obtained by contrast cardiovascular studies.—*James F. Martin, M.D.*

Astley, R., Parsons, C. G., and d'Abreu, A. L. (Birmingham, England.) Cine-angiocardiography. *Proc. Roy. Soc. Med.*, June, 1959, *52*, 457–459.

An early diagnosis of patent ductus arteriosus in infants is important since, after symptoms develop, the prognosis is poor. By angiocardiography, diagnosis is quite accurate and quick and the condition is easily curable. The authors believe that every baby with symptoms of left to right shunt should be examined with this procedure.

The most typical and constant sign is a diastolic dilution defect in the enlarged pulmonary artery. In the left oblique position, the entry of nonopacified blood is first seen as a translucency in the contrast medium near the bifurcation. This extends as far back as the valve, giving an empty appearance that is followed once more by systolic filling from the ventricle. Thus, there is a very characteristic, intermittent contrast filling and emptying of the pulmonary artery. Later, when the left heart fills, there is persistence of contrast in the artery and now a second (systolic) dilution defect, by nonopacified blood from the right ventricle, may present a "bubbly" appearance under the aortic arch. Associated signs are crescentic shape of the small right heart due to indentation of the septum by the large left atrium and ventricle, a large aortic arch and slower than usual left heart clearance.

The main value of cine-angiocardiography is to differentiate septal defects from a patent ductus arteriosus. Here the dilution defect is seen in the contrast medium in the right atrium or ventricle, indicating a left to right shunt. When the left heart fills, there is refilling of the right heart. The pulmonary artery is large and shows persistent filling. The aorta is small and difficult to see.

In pulmonary stenosis, the right oblique position is used. Here there is a narrowing of the outflow tract.

Several graphs and drawings to illustrate the different lesions are included. In the series of 254 cases reported, there were no deaths and technical failures were infrequent, about 2 out of 109.—*Eva S. Carey, M.D.*

Sloman, Graeme. Cine-aortography for the visualization of the aortic valve and coronary arteries. *Proc. Roy. Soc. Med.*, June, 1959, *52*, 460–461. (From: St. George's Hospital, London, England.)

The author discusses the equipment used and technique employed for an initial study he made on dogs. Acetylcholine, used to produce cardiac arrest, improved visualization. On human subjects, only the aortic valve was studied because of the limitation in the size of the roentgen-ray field.

The following are listed as indications for this procedure: (1) in aortic stenosis and regurgitation, to study the movement of the aortic valve leaflets and to assess any aortic regurgitation; (2) in mitral valve disease, when early diastolic murmur is heard at the base of the heart (cine-aortography should allow exclusion of aortic regurgitation); (3) to define the anatomy of aneurysms of the ascending aorta or the sinuses of Valsalva; (4) to visualize the level of various forms of aortic fistulae.

Eight patients were studied and the findings are discussed. The work of the author is not yet complete and he hopes to be able to develop a method for better coronary visualization.—*Eva S. Carey, M.D.*

Piaggio Blanco, Raul A., Dubourdieu, Juan, Urioste, P., and Grosso, Osvaldo, F. (Montevideo, Uruguay.) Sarcoma de esófago. (Sarcoma of the esophagus.) *Radiología, Panamá*, March, 1958, *8*, 47–51.

The authors present a case report of a patient who had sarcoma of the esophagus. They discuss the various types of sarcomas including lymphosarcoma, leiomyosarcoma, myosarcoma, and even rarely,

melanosarcoma. The clinical findings, including the roentgenologic studies, are quite often difficult to differentiate from those of carcinoma of the esophagus. Biopsy is necessary for the diagnosis.—*Charles M. Nice, Jr., M.D., Ph.D.*

Abdomen

Cheli, R., Oliva, L., Dodero, M., and Celle, G. Das bioptische, sekretorische und endoskopische Bild der Magenschleimhaut bei Röntgenbefund hypertrophischer Gastritis. (Bioptic, secretory and endoscopic appearance of the gastric mucosa in cases of roentgen-diagnosed hypertrophic gastritis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, April, 1959, *90*, 403–414. (Address: R. Cheli, Via le Benedetto XV°, Genova, Italy.)

Gastric mucosal folds are affected in size and contour by the muscularis mucosae, muscularis propria, muscle tone, peristalsis, etc. Thus, a normal mucosa may assume different appearances on the roentgenogram.

The authors selected 42 patients in whom the roentgen examination demonstrated large, markedly hypertrophic, localized and generalized, tortuous gastric mucosal folds. No other gastric findings were noted. Gastric symptoms were present in some patients and absent in others. Gastroscopy and biopsy were done in 22 patients, with secretory studies in all. Good correlation was found between the biopsy and secretory findings. A normal histologic picture was present with normal acid values; with atrophic gastritis, achlorhydria was almost always noted.

The roentgen and biopsy findings were widely divergent, the histologic picture being most frequently that of pre-atrophic and atrophic gastritis. The gastroscopic observations supported the roentgen findings in the majority of instances. It should be emphasized that, in cases of hypertrophy of the mucosa, the biopsy usually showed evidence of gastritis. Accordingly, in the event of a roentgen finding of hypertrophy of the gastric rugae, a thorough investigation of the gastric mucosa seems important because this is so frequently indicative of gastritis.—*Samuel Richman, M.D.*

Cavins, John A., Levin, Hugh S., and Day, H. James. Chronic myelogenous leukemia with gastric infiltration; report of a case simulating carcinoma of the stomach. *New England J. Med.*, May 28, 1959, *260*, 1111–1114. (From: The Departments of Medicine and Hematology, Ohio State University Health Center, Columbus, Ohio.)

The patient in the case described sought medical advice because of fullness in the epigastrium of three months' duration. Subsequently the discomfort became a frank, burning epigastric pain. Roentgenographically, the patient appeared to have a carcinoma of the stomach. Blood studies revealed the presence of chronic myelogenous leukemia.

The gastric lesion, which at laparotomy had the typical appearance of carcinoma, was proved microscopically to be a localized infiltration of leukemic cells into the stomach wall.—*James J. McCort, M.D.*

Pochaczevsky, Rubem, and Sherman, Robert S. The roentgen appearance of gastric argentaffinoma. *Radiology*, March, 1959, *72*, 330–337. (Address: R. Pochaczevsky, 444 East 68th St., New York 21, N. Y.)

Three cases of primary argentaffinoma of the stomach are reported adding to the 59 already described in the literature. One of these 3 is the second known example of such a tumor with the carcinoid syndrome. Also reported is an argentaffinoma of the ileum with carcinoid syndrome which metastasized to the stomach. An extensive review of the literature is given.

The roentgen manifestations of these tumors, based on the authors' experience and descriptions in the literature, are found to be somewhat variable and nonspecific. Almost always, however, they are indicative of some type of neoplasm, most often a polyp or gastric carcinoma. The great majority appear as small, sharply circumscribed, polypoid filling defects of rounded shape covered with an apparently smooth mucosa. Occasionally, central ulceration is present on the surface of the polypoid mass. Their location may be anywhere within the stomach, although they are less commonly found in the cardia and fundus.

The authors believe that although argentaffinomas are rare tumors they should be included in the differential diagnosis of polypoid filling defects in the stomach, especially if the patient has a long history of stomach disease and if the symptomatology is at all suggestive of a carcinoid syndrome.—*Donald N. Dysart, M.D.*

Barrick, Claude W., and Fry, Kenneth E. Meckel's diverticulum; a case diagnosed by x-ray. *A.M.A. Arch. Surg.*, June, 1959, *78*, 934–936. (From: Departments of Radiology and Surgery, Jefferson Medical College Hospital, Philadelphia, Pa.)

The authors present a very interesting case of Meckel's diverticulum and discuss its incidence, the diagnostic difficulties it presents to the radiologist and, briefly, its symptoms and histology. The lesion was misdiagnosed in this particular case as a small bowel tumor and it certainly did not present the usual roentgen appearance of a diverticulum, since it was inverted. The authors believe that, since on

the roentgenograms the defect was the same caliber from base to tip and covered by normal mucosa, the diagnosis should have been obvious.

They take this opportunity to question the accuracy of some roentgen examinations of the small bowel when the radiologist is too busy to take the time for a thorough fluoroscopic study, mucosal fold by mucosal fold. They close the discussion by reaffirming the well known adage that diagnostic skill and accuracy depend on past experience coupled with precise methods of examination.

Excellent reproductions of roentgenograms are included with this well written case report.—*Eva S. Carey, M.D.*

Orsoni, P., Lemaire, M., and Fortier-Beaulieu, M. (Paris, France.) Angiographie sur pièces du jéjunum. (Angiographic studies on anatomic specimens of the jejunum *J. de. radiol., d'électrol. et de méd. nucléaire*, May, 1959, *40*, 229–235.

Dissection by anatomists and surgeons in the past has provided the knowledge we have today of the arterial anatomy of the jejuno-ileum. The authors of the present article investigated the small bowel arterial supply by means of roentgenograms taken after the injection of contrast material in 20 anatomic specimens.

After reviewing the classic theories as given by anatomists on small intestinal vasculature, they summarize the technique used in their work. The small intestines were removed as a whole and placed on a roentgenographic table. The superior mesenteric artery was catheterized and hydrosoluble iodinated material was injected. The corresponding vein was also injected with a small amount of contrast material and was continuously inflated with air by means of a blower. Roentgenograms were then made using 50 kv. and 100 ma. at 1/10 second.

Roentgenographic reproductions of seven specimens are presented before and after sectioning of the jejunal arteries, which are usually resected when a jejuno-esophagoplasty is performed. In this way, they were able to demonstrate the caliber and distribution of the vessels, especially at the level of the juxta-intestinal arterial arcades. It was also possible to check what resulted functionally after these arcades were deprived of their main arterial supply.

The description by anatomists of the intestinal arterial network was found to be insufficient and inaccurate. For example, it was noted that the caliber of the primary arterial arches was not uniform but rather diminished gradually as the vessel recedes from the main arterial branch and was minimal at the top of the arcades. Also, the secondary and tertiary arcades were found to be more numerous close to the bifurcation of the main arterial branch and less so at the level of the primary arcades, where their diameter is minimal.

In this investigation, many variants of the arterial network were observed. The authors point out the frequent occurrence of a "segmental type" of blood supply, where each jejunal loop was almost exclusively nourished by a main jejunal artery. They also noted the rarity of the "continuous type" of vascularization in which the primary arterial arches possessed a more uniform caliber and where the anastomoses were numerous and equally distributed.

In their conclusion, an evaluation of the jejunum for gastrointestinal surgery is made and the best material for transposition is considered.—*Henri-Paul Lévesque, M.D.*

Ochsner, Seymour Fiske, Ray, John E., and Clark, Wallace H., Jr. Lymphangioma of the colon; a case report. *Radiology*, March, 1959, *72*, 423–425. (Address: S. F. Ochsner, Ochsner Clinic, New Orleans, La.)

The authors present a case report on a fifty-one year old white female who was found to have a polypoid lymphangioma of the colon. This lesion was demonstrated on roentgenograms after thorough preparation of the colon as an ovoid, pedunculated, polypoid type mass measuring 5 by 3.5 cm. and located in the transverse colon near the hepatic flexure. Its smooth contour and radiolucency suggested that it might be a lipoma. The tumor was successfully removed by segmental resection of the transverse colon. Grossly, it was pale yellow, soft, smoothly outlined and pedunculated, measuring 6×4×2 cm. On section, small, multiloculated, cystic areas about 0.5 cm. in diameter could be seen. The microscopic picture was typical of lymphangioma. This is believed to be the second lymphangioma of the colon recorded in the literature. Lymphangioma of the rectum in 3 patients and of the small intestine in 6 patients has been reported in the English literature. —*W. M. McBride, M.D.*

Rider, J. Alfred, Kirsner, Joseph B., Moeller, Hugo C., and Palmer, Walter L. Polyps of the colon and rectum; a four-year to nine-year follow-up study of five hundred thirty-seven patients. *J.A.M.A.*, June 6, 1959, *170*, 633–638. (Address: J. B. Kirsner, 950 E. 59th St., Chicago, Ill.)

In a six year period, 9,669 proctosigmoidoscopic and roentgenographic examinations resulted in detection of polyps in 537 patients. A vigorous follow-up program from four to nine years later revealed that new polyps developed in approximately 40 per cent of these patients, indicating the need for frequent re-examination. The incidence of carcinoma of the colon was twice as high in patients with multiple polyps. Local removal appeared to be adequate treatment for benign polyps and for adenocarcinoma within reach of the proctosigmoidoscope.

The authors recommend that patients with polyps be examined annually until the findings of at least five consecutive yearly proctosigmoidoscopic and roentgenologic examinations of the rectum and colon have been negative.—*James J. McCort, M.D.*

Engels, E. P. Sigmoid colon and urinary bladder in high fixation: roentgen changes simulating pelvic tumor. *Radiology*, March, 1959, *72*, 419–422. (Address: 572 Lowry Medical Arts Bldg., St. Paul 2, Minn.)

The author presents a composite report of 5 unusual cases in which the roentgenograms revealed simultaneous deformities of the sigmoid colon, the urinary bladder and the prostatic urethra. The patients, all males between the ages of thirty-eight and eighty years, presented similar histories in that all but one complained of urinary frequency, backache, and episodic pain over the bladder area. The other patient was admitted for evaluation of a lower abdominal "mass" (bladder) and presented none of the above symptomatology. Cystograms were done in each case and revealed an elongated bladder, shaped like a gourd or banana, resting unusually high above the symphysis pubis. The prostatic urethra likewise was elongated. Barium enema studies showed the sigmoid colon to rise vertically out of the pelvis toward the umbilicus. The colon was distensible with no rigidity or fixation and the postevacuation mucosal pattern was normal.

Due to suspicion of a pelvic tumor, laparotomy was performed in 4 cases. The patient with the "mass" (bladder) was found to have a large amount of fat in the lesser pelvis and a urachal remnant connecting the dome of the urinary bladder and the sigmoid colon to the umbilicus. In the other 3 patients, extensive adhesions were found between the urinary bladder, pelvic colon, and the anterior abdominal wall. These adhesions were apparently secondary to chronic urinary tract infections. The fifth patient was not operated upon since the history suggested that the findings were produced by adhesions of similar origin.

The roentgen appearance in such benign conditions may remotely simulate the changes produced by a pelvic neoplasm and, when associated with the clinical findings described, may lead to unnecessary surgery.—*Edward B. Best, M.D.*

Poppel, Maxwell H. Some migratory aspects of inflammatory collections of pancreatic origin. *Radiology*, March, 1959, *72*, 323–329. (Address: 550 First Ave., New York 16, N. Y.)

Within the past ten years more than 30 patients have been seen in whom inflammatory collections of pancreatic origin migrated to various regions in the abdomen or thorax. In many instances these inflammatory collections presented at a distance as the initial phase of the disease, masquerading as a local abscess, a perinephritic abscess, a subphrenic abscess, a fistula, a pleurisy, an empyema, a mediastinal mass, an appendictis, a perityphlitis, an abscess in the left iliac fossa, a collection in the lesser sac, and as a true cyst.

Many illustrations are given showing the various roentgenographic manifestations of these collections in the different areas of involvement.—*Donald N. Dysart, M.D.*

Arcomano, Joseph P., Barnett, James C., and Immerman, Lewis L. Orabilex: a new cholecystocholangiographic medium; its use in visualizing the nonvisualized gallbladder and in oral cholangiography. *Am. J. Digest. Dis.*, June, 1959, *4*, 466–478. (Address: J. P. Arcomano, North Shore Medical Group, 325 Park Avenue, Huntington, L. I., N. Y.)

Orabilex, used for a series of 112 patients, has compared favorably with other agents in the ability to produce reliable gallbaldder visualization and has proved superior to others in reducing side reactions.

For oral cholecystography, six 0.75 gm. capsules are taken fourteen hours prior to the roentgen-ray examination. In attempting to visualize the initially nonvisualized gallbladder and in oral cholangiography, the dosage is increased to a total of eighteen 0.75 gm. capsules, six given in combination with paregoric at seventeen, thirteen and four hours prior to the examination. No patient has been incapacitated because of vomiting or diarrhea.

Few instances of nonvisualization of the gallbladder resulted when higher dosage levels of orabilex were used, and to date surgery has demonstrated pathology to be present in each instance.

In attempting to visualize the common duct after cholecystectomy, the authors' initial results have been comparable to results previously obtained using intravenous cholangiography, with both a saving in time and without the necessity of intravenous injection.—*William C. MacCarty, Jr., M.D.*

Raboni, F., and Bossi, A. Sul valore morfologico della colangiografia peroperatoria; contributo casistico. (The morphologic value of operative cholangiography; case reports.) *Ann. radiol. diag.*, 1958, *31*, 441–475. (From: Istituto di Radiologia e del Radium dell 'Università di Parma, and Istituti Ospitalieri "C. Poma" di Mantova, Mantova, Italy.)

The anatomy and physiology of the extrahepatic biliary tract are thoroughly covered in the introduction of this article.

The technique used by the authors is the same as that used by other investigators and offers nothing new. About 20 to 30 cc. of contrast medium is in-

troduced at the time of surgery, either directly into the gallbladder or into the cystic duct or common duct. Serial roentgenograms are taken during this procedure.

The cases reported are concerned with diseases of the cystic duct and include anomalous insertions of the cystic duct into the common duct, stones and inflammatory diseases of the cystic and common duct, abnormalities of the ampulla, and neoplasms of the ampulla of Vater.

The authors find that this method has proved to be free of any serious complications or risk to the patient. It offers to the surgeon exploration of areas which otherwise are difficult to investigate by any other method.

The authors do not claim to present anything new but re-emphasize the many advantages of the method for more correct diagnosis in this field of surgery.

The article includes a very extensive bibliography on the subject of operative cholangiography.—*Peter E. Russo, M.D.*

ARIANOFF, A. A., and HENRARD, ET. H. (Bruxelles, Belgium.) L'apport de la cholangiographie peropératoire en série sous contrôle manométrique au cours de 645 interventions sur les voies biliaries. *Acta gastro-enterol. belg.*, Feb., 1959, *22*, 101–117. (The contribution of preoperative cholangiography in a series of 645 biliary tract operations under manometric control.)

Surgery of the biliary tract occupies a special place partly because the tract is located in the center of vital organs which are affected by organic and functional changes and partly because the caliber of the ducts is only a few millimeters.

Objections to peroperative cholangiomanometry are: (1) the patient is not in a good surgical position; (2) loss of time; and (3) danger of infection, acute hemorrhagic pancreatitis and cholangitis. These objections may be overcome by experience and adequate technique. Recent myocardial infarct, however, is a definite contraindication.

The procedure has given valuable diagnostic information in 90 per cent of the cases. Detection of small stones and obstructions, avoidance of the risk of a residual cystic duct stump, and evaluation of the biliary tract topography are important. Internal biliary fistulas may be demonstrated. Intrinsic and extrinsic lesions of the hepatic and common ducts may be found as well as functional disturbances of the sphincters of Mirizzi and Wirsung.

Therapeutically, the procedure: (1) permits to decide the necessity of cholecystectomy; (2) assists in performing a complete and correct cholecystectomy; (3) provides indications on how to terminate a choledochotomy; (4) helps to determine, the best approach in the presence of a fistula or stenosis; (5) aids in establishing whether a duodenotomy is necessary; and (6) in re-operation, enables to determine the cause of the postcholecystectomy syndrome.—*Marcy L. Sussman, M.D.*

BENSON, CLIFFORD D., and REINERS, CHARLES R. Asymptomatic abdominal masses in infants and children. *A.M.A. Arch. Surg.*, May, 1959, *78*, 688–697. (Address: C. D. Benson, 1515 David Whitney Building, Detroit 26, Mich.)

The authors stress the value of careful examination of the abdomen in the infant or child for detection of asymptomatic abdominal masses. The finding of an abdominal mass under these circumstances is of great importance to the patient because it affords the physician the opportunity to treat the lesion not only when the possibility for cure exists but when the chance for cure can be greatly increased.

The authors review their experience during the past sixteen years with patients in the pediatric age group who have been referred by the pediatricians on discovery of an abdominal mass after careful routine examination. There were no clinical symptoms directly referable to the mass in 26 of these patients. The diagnoses were as follows: Wilms' tumor, 7; unilateral multicystic kidney and congenital hydronephrosis, 6; teratoma, 3; hamartoma (right lobe of the liver), 2; neuroblastoma, 3; miscellaneous, 5.

Every infant or child who presents an abdominal mass should have a scout roentgenogram of the abdomen and an intravenous pyelogram, a complete blood count and examination of the urine preoperatively.

The abdominal mass was proven to be malignant in 12 of the 26 patients, with an over-all survival rate of 58 per cent. Two patients were lost to follow-up. Of the remaining 24 patients, 18, or 75 per cent, are surviving and well.

These results emphasize that if an asymptomatic mass can be detected in an infant or child before obvious clinical symptoms occur, the prospect for survival and cure is encouraging.—*James F. Martin, M.D.*

GOLDSTEIN, M. De l'importance de la radiographie sans préparation dans le diagnostic des affections abdominales aiguës. (On the importance of radiography without preparation in the diagnosis of acute abdominal diseases.) *Acta chir. belg.*, Jan., 1959, *58*, 23–56. (From: Service de Chirurgie générale de l'Hôpital universitaire Saint-Pierre, Bruxelles, Belgium.)

In the normal adult, gas is found in the stomach, the hepatic and splenic flexures and at the summit of the sigmoidal loop. Quite often there is gas also in the duodenal bulb or at the apex of the "genu su-

perius." Gas in the small bowel of normal caliber is not a sign of obstruction. This is found classically in infants. Most of the gas is swallowed but some arises from the decomposition of alimentary residues. The fluid which accumulates in obstructions is the result of incomplete absorptions by an impaired mucosa, accumulation of secretions and plasma exudation.

A difference is noted by many authors between the fluid-gas shadows in the small bowel and the colon. In the former, the loops are wider than they are high.

Fluid-gas shadows may be seen sometimes with a localized suppuration but the superior margin does not have the contour of intestine.

Pathologic fluid levels may be seen as follows:

(*1*) *Stomach.* The gastric air bubble may be modified by extrinsic pressure and its internal structures may be altered by ulcer or neoplasm. Dilatation may occur in various types of obstruction, in pancreatitis and in all acute lesions of the digestive tract. Vomiting may reduce the distention. Pyloric stenosis will increase the fluid and air. Gastric volvulus or diaphragmatic hernia presents in two different ways: (a) the stomach contracts in its middle around the cardiopyloric axis, and (b) the stomach is plicated along a transverse axis, the pylorus becoming subphrenic with two superimposed gas shadows.

(*2*) *Small Intestine.* Gas in the ileum may be explained by insufficiency of the ileocecal sphincter. It may appear after enemas, and if may occur in the presence of reflex ileus. The localization of small bowel gas may be specific. Some authors consider the loops independent of one another and in jujeno-ileal obstruction they extend from the left hypochondrium to the right iliac fossa. A stepladder appearance may be found and suggests jejunal obstruction; the ileal loops are more vertical. According to Clavel, if the loop forms a Roman arc, the obstruction is due to a band; if the arc is asymmetric and its extremities resemble a horseshoe, there is a partial volvulus. There may be a single "scutinal" loop. This has been found in acute pancreatitis and localized segmental ileus.

(*3*) *Colon.* When a single loop is dilated, differentiation from small bowel may be difficult and may require a barium enema study. Occasionally, a paradoxical situation is found when a low colonic obstruction produces dilatation of the colon, while competence of the ileocecal valve produces a second obstruction of the small bowel.

(*4*) *Ascites.* It is difficult to demonstrate free intraperitoneal fluid and to differentiate fluid in the intestinal loops. If there is intestinal meteorism, the diagnosis is easier, the wall of the bowel appearing thickened, but there will be confusion with inflammatory thickening of the wall.

(*5*) *Free Air Outside of the Digestive Tract.* Differentiation of a fluid level in bowel from air in an abscess may be difficult. Air under the diaphragm is due in 15 per cent of cases to perforation of the digestive tract and in 25 per cent to other causes (intestinal pneumatosis, pneumothorax, abdominal trauma). It has also been found with a gangrenous appendix. Closure of a perforation, adhesions, etc. prevent the appearance of positive signs.

(*6*) *Time of Appearance of Fluid Levels.* Fluid levels appear five to six hours, and even perhaps three hours after obstruction.—*Marcy L. Sussman, M.D.*

Nice, Charles M., Jr. Abdominal abscesses in children. *South. M. J.*, June, 1959, *52*, 659–666. (From: The Department of Radiology, University of Minnesota Hospitals, Minneapolis, Minn., and the Division of Radiology, Department of Medicine, Tulane University School of Medicine and the Department of Diagnostic Radiology, Charity Hospital of Louisiana, New Orleans, La.)

The diagnosis and management of abdominal abscess have undergone considerable change since the introduction of sulfonamide and antibiotic therapy. The author reviews the appropriate roentgen studies which may be of considerable aid in the diagnosis and care of these patients.

Abdominal abscess is classified according to topography as follows: (1) abscess of the abdominal wall: (a) related to the umbilicus, (b) other abscesses of the abdominal wall; (2) intraperitoneal abscess: (a) related to the gastrointestinal tract, (b) related to other intraperitoneal organs, (c) extravisceral intraperitoneal abscess; (3) extraperitoneal intra-abdominal abscess: (a) related to specific organs, (b) extraperitoneal abscesses not related to organs.

The author gives a brief discussion of the etiology of abdominal abscess in children including wounds (traumatic and postoperative), perforated viscus and such rare conditions as puerperal sepsis. The pathogenesis may not be clear in some cases.

The roentgen signs which are of value in the diagnosis of abdominal abscess include: mass lesion; gas-fluid level outside of bowel; gas bubbles outside of bowel; fluid formation between bowel loops; localized or generalized adynamic ileus; single or multiple areas of partial obstruction; foreign bodies; blurring of soft tissue margins, renal, psoas, etc.; elevation and splinting of the diaphragm; atelectasis, pneumonitis, or pleural fluid above the diaphragm; and multiple lesions.

The author stresses the paramount importance of the roentgen examination. Roentgenograms in the supine and erect positions in the anteroposterior or posteroanterior views constitute the minimum requirement. The lateral decubitus views of the abdomen as well as lateral views in both recumbent and upright positions are also recommended to provide further information concerning accurate localization and extent of the process.

The importance of possible infection in vestigial

remnants of the urachus and vitelline duct, alimentary duplication cysts, intussusception and strangulated loops of bowel in the differential diagnosis is emphasized.

Eight cases of abdominal abscess are reported briefly with comments on the clinical course and the value of the roentgen examination.—*James F. Martin, M.D.*

Brogdon, Byron G., and Crow, Neil E. Observations on the "normal" spleen. *Radiology*, March, 1959, *72*, 412–414. (Address: B. G. Brogdon, USAF Hospital, Lackland AFB, Texas.)

Practically all affections of the spleen are manifested morphologically by its enlargement. The authors have reviewed 936 roentgenograms of the abdomen of healthy young males made in the anteroposterior projection during expiration, utilizing a 36 inch target film distance. They observed that the lower pole of the spleen was visualized in 44.4 per cent of these patients. Nonvisualization was not considered pathologically significant.

Determination of the size and position of the spleen was based on roentgenograms taken in the recumbent position in 89 cases and the erect position in 302 cases. The average width of the normal spleen at a point 2 cm. above the tip of the inferior pole is 3.4 cm. This measurement may be used as an index of splenic size in the roentgen diagnosis of splenomegaly. The tip of the spleen usually lies at the level of the vertebral body L-2 in both erect and recumbent positions, but ranges toward lower levels in the former position. The ranges of normal size and position are given.—*W. M. McBride, M.D.*

Boley, Scott J., McKinnon, William M. P., and Schwartz, Solomon S. Traumatic rupture of the spleen in children. *Surg., Gynec. & Obst.*, July, 1959, *109*, 78–84. (From: Department of Surgery, Queens Hospital Center; Pediatric Surgical Division and Department of Radiology, Jewish Hospital of Brooklyn; and Department of Surgery, Maimonides Hospital of Brooklyn, Brooklyn, N. Y.)

An extensive study of 33 children with traumatic rupture of the spleen was made, which included the significant roentgenologic, clinical, and laboratory findings. The authors saw no demonstrable clinical or roentgenographic evidence of hemorrhage in two-thirds of the patients and they emphasize that this classically described finding in rupture of the spleen was most often absent in their series. A control series of 200 plain roentgenograms of the abdomen of infants and children suffering from conditions *other* than splenic rupture demonstrated all the roentgen signs described for splenic rupture. The study showed no roentgenologic sign which was pathognomonic of ruptured spleen, and the roentgenographic findings are only helpful when correlated with the clinical picture.

The diagnostic triad of a history of trauma, abdominal and/or shoulder pain, and abdominal tenderness and muscle guarding (especially when localized to the left upper quadrant) has been suggested as most informative. The authors recommend exploratory laparotomy in children presenting this triad, regardless of the roentgenographic findings.

The authors describe the difficulties inherent in diagnosing rupture of the spleen in children and question the diagnostic importance of signs of blood loss in this condition. In their experience, it was of no help.

The clinical and roentgenologic studies presented dispel any idea that the diagnosis of this condition in young patients is either easy or clear cut.—*Roscoe E. Miller, M.D.*

Gynecology and Obstetrics

Stevens, Harold, and Ammerman, Harvey H. Intracranial venous thrombosis in early pregnancy. *Am. J. Obst. & Gynec.*, July, 1959, *78*, 104–108. (From: Department of Neurology and Neurosurgery, George Washington University School of Medicine, Washington, D. C.)

Cerebral venous thrombosis associated with pregnancy is sufficiently frequent to warrant the inference that there is a causative relationship. The exact reason for venous thrombosis in the pregnant or post partum patient is unknown. Several theories have been advanced, but none seems to be completely adequate.

The authors report on 2 patients who were in the first trimester of pregnancy; one had occluded cerebral veins and the other thrombosed cerebellar veins. In both instances progressive focal neurologic signs were present along with headache, stupor and increased intracranial pressure. In the first patient a decompression craniotomy was done and gestation proceeded satisfactorily. In the second patient, where the lesion was in the posterior fossa, a Torkildsen procedure was carried out. The patient recovered promptly and delivered a normal infant at full term.—*Frank J. Rigos, M.D.*

Sackner, Marvin A., Dex, Walter J., and Kaplan, Alvin I. Sickle cell-hemoglobin C disease and pregnancy, including a case of osteomyelitis. *Am. J. Obst. & Gynec.*, June, 1959, *77*, 1328–1337. (From: Philadelphia General Hospital, Philadelphia, Pa.)

Sickle cell hemoglobin C disease, a genetic variant of sickle cell anemia, is usually characterized by mild hemolytic anemia, large numbers of target cells on the peripheral blood smear, and splenomegaly. Occasionally it is asymptomatic; however, severe

crises comparable to those occurring in sickle cell anemia have been observed. There are reports that pregnancy increases the degree of hemolytic anemia and precipitates crises.

This article deals with a family in which 4 females have sickle cell hemoglobin C disease. They had nineteen pregnancies among them and four crises documented during the pregnancy period. In addition, an unusual complication, acute hematogenous osteomyelitis, followed one of these crises.

The clinical, laboratory and roentgenographic characteristics are described. It is suggested that patients with sickle cell hemoglobin C disease are no more prone to crises during pregnancy than patients with sickle cell anemia. However, crises during pregnancies may be the only times when the sickle cell hemoglobin C disease is symptomatic.—*Eugene J. McDonald, M.D.*

King, Edward L., Dyer, Isadore, King, John A., and Hoffman, Milton J. Clinical evaluation of pelvicephalography; review of 1,200 cases. *J.A.M.A.*, July 4, 1959, *170*, 1165–1169. (Address: E. King, 1521 Delachaise St., New Orleans, La.)

In view of the questions raised recently concerning the possible deleterious effects of radiation used late in pregnancy on the mother and infant, the authors reviewed 1,200 cases of pelvicephalography in order to evaluate the clinical yield of this procedure.

In the years 1946–1947, among 702 patients, antenatal roentgen-ray pelvimetry was used in 272, while in the years 1956–1957, the total was 44 of 597. In the 1946–1947 series, 2 per cent of term babies were lost from conditions not related to delivery, such as toxemias and erythroblastosis; while in the 1956–1957 series only 0.8 per cent fetal loss occurred from conditions not related to delivery.

No correlation was found between head volume and the weight of the baby. In 44 patients with disproportion, in whom trial labor failed, 14 had only moderate cephalopelvic disproportion. The authors believe that, with proper clinical evaluation of the pelvis, roentgenographic examination is needed in only about 20 per cent of patients, and, since these roentgen studies are not conclusive, the radiologist should not make an obstetrical prognosis. Routine pelvicephalography is not recommended, since careful clinical study will suffice in 70–80 per cent of obstetric patients.—*J. A. Campbell, M.D.*

Jeffcoate, T. N. A., and Scott, J. S. Polyhydramnios and oligohydramnios. *Canad. M.A.J.*, Jan. 15, 1959, *80*, 77–86. (From: The Department of Obstetrics and Gynaecology, University of Liverpool, Liverpool, England.)

Studies with radioactive isotopes have clearly demonstrated that the pool of liquor amnii is not a static reservoir. Both the fluid and its chemical contents are in a state of continual flux. The volume of liquor, however, remains fairly constant for each particular stage of pregnancy. The normal volume and pathologic variations constituting polyhydramnios and oligohydramnios are likely to be determined by the relative efficiency of the mechanisms for production and disposal.

The possible origin and disposal of liquor amnii are discussed in considerable detail. Briefly, they are considered as follows:

(1) *Origin of Liquor Amnii:* (a) From or through the membranes. Liquor appears early in the pregnancy, when the fetal tissues are undeveloped and nonfunctional. It is found within the sack in which the fetus is absent or rudimentary. Such observation strongly suggests that fluid enters via the membranes. (b) From the fetus. The parts of the fetus that might secrete fluid are the skin and its appendages, the respiratory tree and the kidneys.

(2) *The Disposal of Liquor Amnii:* (a) Through the membrane. The amnion might absorb as well as secrete fluid or, depending upon osmotic pressures, at least allow a transudation back into the maternal circulation. (b) Absorption by the fetus. Fetal skin, like amnion, might absorb water, but this is more likely when it is represented by primitive ectoderm. The fetal respiratory tract might also form a disposal route, at least after mid-pregnancy. The pathway which seems most likely to offer an exit for substantial amounts of fluid is the fetal alimentary canal.

A review of 169 consecutive cases of hydramnios revealed that in 52 (32 per cent) the excess amount of liquor was associated with a malformation which would probably interfere with the fetus' swallowing or absorbing liquor amnii from the intestines. These conditions were as follows: anencephaly, iniencephaly, hydrops fetalis with gross edema of the lips, esophageal atresia, duodenal atresia, and diaphragmatic hernia.

Oligohydramnios is recorded less frequently than polyhydramnios, possibly because it tends to pass unnoticed. In the first half of pregnancy oligohydramnios is not seen as a recognizable clinical entity. In late pregnancy the finding often indicates that the fetus *in utero* is suffering from a gross renal abnormality or from an obstructive lesion in the lower urinary tract. Roentgenograms of the uterus and its contents are said to show typical signs of oligohydramnios. These result from compaction of the fetus and consist of extreme flexion of the spine and crowding of the skeleton toward the pelvic cavity. The appearance is similar to that described for fetal death *in utero*, except that Spalding's sign is absent.

Attention is drawn to changes in the amnion which are almost specific, mainly "amnion nodosum." These are small nodules or plaques on the fetal aspect of the amnion, consisting of masses of keratinized squamous cells embedded in an acidophil matrix. In normal pregnancies squamous cells are cast from the fetal skin into the liquor amnii and

float freely. When the amount of fluid is suspicious, however, unusual friction leads to excessive desquamation from the fetal skin and the desquamated cells, having little if any fluid in which to circulate, become deposited on the amnion.

The exact place of fetal micturition and deglutition in normal physiology remains to be decided, but failure of one or the other is practically always associated with a disturbance of liquor volume. Provided the other mechanisms for the production and absorption of liquor operate normally, pathologic conditions of the fetus which are incompatible with fetal micturition cause oligohydramnios, while lesions which prevent the fetus swallowing and absorbing liquor from the intestines result in polyhydramnios. Irrespective of their cause, oligohydramnios retards fetal growth and polyhydramnios encourages it.—*John F. Weigen, M.D.*

GETZOFF, PAUL L., and FOWLER, ROGER. Severe pyelonephritis of pregnancy. *South. M. J.*, June, 1959, *52*, 638–642. (From: The Departments of Urology and Obstetrics and Gynecology, Touro Infirmary, New Orleans, La.)

It has been estimated that pyelonephritis of pregnancy not only has a deleterious effect on the mother's health but trebles the infant mortality.

Acute pyelonephritis is primarily a disease of the interstitial tissues of the kidney; the tubular elements are involved in varying degrees. The renal pelvis and ureter may be involved. The morphologic characteristics of the disease are basically identical, regardless of whether the infection is hematogenous, urogenous or lymphatic in its origin. It is suggested that the term "pyelitis of pregnancy" be discarded because histologic evidence reveals that pyelitis rarely exists unaccompanied by pyelonephritis.

The dilatation is usually limited to the renal pelvis and the abdominal ureter. Physiologically, there is no dilatation of the distal ureter. In 95 per cent of cases where this occurs in normal pregnancies, the right renal pelvis and ureter are involved. Bilateral involvement is less common but not rare.

The authors have observed peripheral edema and albuminuria in several patients who had pyelonephritis of pregnancy without toxemia. The severe complications of pyelonephritis of pregnancy present a special problem because some of these manifestations can become evident before the primary disease has been suspected. Included in this group are renal carbuncle, perinephric abscess, secondary renal lithiasis, thrombophlebitis of the renal vein, and spontaneous perirenal hematoma.

Pyelonephritis of pregnancy can masquerade as toxemia of pregnancy. Hypertension with or without retinal changes, slight postural and dependent edema, and albuminuria may occur with pyelonephritis as well as with toxemia during pregnancy. Both pyelonephritis of pregnancy and toxemia of pregnancy can be present simultaneously.—*Eugene J. McDonald, M.D.*

WEINBERG, C. RICHARD. Hysterosalpingography with a new water-soluble medium (sinografin). *Surg., Gynec. & Obst.*, June, 1959, *108*, 679–682. (From: The Departments of Radiology and of Obstetrics and Gynecology, The Harrison S. Martland Medical Center, Newark, New Jersey.)

Water soluble media designed to obviate the problems associated with oily media have generally proved not to be satisfactory because of poor technical results or, in some cases, because of difficulty from ingredients—usually carboxymethylcellulose—added to increase viscosity.

Sinografin is an aqueous solution of the methylglucamine salts of diatrizoate and iodipamide. Diatrizoate is present (as the acid) in 40 per cent concentration, iodipamide (as the acid) in 20 per cent concentration. The formula as supplied contains approximately 38 per cent iodine. No viscosity additives are present.

Each of the components of sinografin has been shown, when used separately, to be an effective and safe radiopaque medium. Diatrizoate methylglucamine has been successfully employed in intravenous urography, in cerebral angiography, and in aortography.

Iodipamide methylglucamine has been employed extensively in intravenous cholangiography and cholecystography with resulting excellent contrast, without serious reactions.

The successful and extensive intravenous use of both of these components of sinografin, either separately or combined, denotes the safety of this preparation for intrauterine injection, even though some of the material may inadvertently enter the blood stream by accidental intravasation.

The contrast density and viscosity of the preparation appear to be well suited for this purpose. Following its injection into the uterus, the medium readily flows from the uterus into the tubes, outlining both the uterine and tubal cavities.—*Eugene J. McDonald, M.D.*

DUFRESNE, MAURICE R., GÉRIN-LAJOIE, LEON, and MALTAIS, ROGER. Problems in hysterosalpingography. *J.A.M.A.*, July 4, 1959, *170*, 1169–1171. (Address: M. Dufresne, 1560 Sherbrooke St. E., Montreal, Quebec, Canada.)

The diagnostic usefulness of hysterosalpingography is evaluated from a critical study of 395 cases. Accuracy of diagnosis approaches 100 per cent in the recognition of congenital anomalies and malformations but is less than 10 per cent in detecting endo-

cervicitis, where false positive signs are common. A high degree of diagnostic error was also found in endometrial hyperplasia and endometritis. The authors question whether the so-called characteristic picture of tuberculous salpingitis is valid and doubt if a firm diagnosis of this condition can be made by hysterosalpingography.

The rates of diagnostic accuracy for this method in their experience are as follows: congenital anomalies (100 per cent), cancer of the corpus uteri (100 per cent), salpingitis with hydrosalpinx and tubal obstruction (93 per cent), polyps of the uterine cavity (75 per cent), ovarian cysts (70 per cent), endocervical polyps (65 per cent), fibromyomas (58 per cent), ectopic pregnancies (50 per cent), and endocervicitis (10 per cent).—*J. A. Campbell, M.D.*

Reiss, H. E. The cervix in hysterosalpingography. *J. Obst. & Gynaec. Brit. Emp.*, April, 1959, *66*, 317–318. (From: Obstetric Unit, University College Hospital, London, England.)

The chief drawback of the traditional type of cannula used in hysterosalpingography is that the tip of the instrument enters the cervical canal for an appreciable distance and obscures its outline. Contrast medium is injected directly into the uterine cavity, and the cervix is by-passed.

For these reasons, the need arose for a cannula which would neither pass through the internal os nor distort the cervical canal. Only thus could the true appearance of the canal be demonstrated, and a reliable diagnosis of incompetence of the internal cervical os be made.

The instrument consists, basically, of a straight cannula, 26 cm. long, having at one end a Luer fitting mount, and at the other a screw thread superimposed 25 mm. from the tip, and extending for a length of 35 mm. Onto the thread is screwed a silver cup, 20 mm. in diameter and 10 mm. deep, having at one point an obliquely cut slot. A balloon type of catheter, of suitable gauge and of 30 ml. capacity, is adapted to the cannula by the removal of that part distal to the balloon, and by cutting of a lateral notch immediately under the balloon. The distal end of the cannula has been strengthened in order to accommodate a post to which tenaculum forceps can be attached.

The instrument is assembled by screwing the cup onto the cannula, followed by the passing of the balloon over the tip of the cannula. The balloon is now inflated and is set down into the cup. Enough of the cannula (approximately ½ cm.) projects to secure a hold in the cervical canal. The inflated balloon forms an effective seal between the concavity of the cup and the convexity of the cervix.

The single-toothed tenacula are used to supply countertraction and a better seal is obtained if they are applied laterally rather than anteroposteriorly. The balloon is now inflated by means of a syringe to a size which must vary with that of the cervix under examination. Usually 5 to 10 cc. of air suffices. Satisfactory roentgenograms of the cervix, uterus and tubes are obtainable with this instrument.

There are further advantages associated with the use of the short tip cannula. It avoids the pain associated with the passage of the traditional type of cannula through the internal os; reflex tubal spasm due to endometrial trauma is avoided. Furthermore, in cases of bicornuate uterus, it avoids the confusion caused by passage of the long cannula into one horn only.—*Stephen N. Tager, M.D.*

Lembeck, F., and Maresch, W. Tödliche Kontrastmittelembolie bei Hysterosalpingographie. (Fatal contrast material embolism after hysterosalpingography.) *Wien. klin. Wchnschr.*, May 29, 1959, *71*, 390–392. (From: Institut für Pharmakologie und Institut für Gerichtliche Medizin der Universität Graz, Graz, Austria.)

One case is reported in which hysterosalpingography with a water soluble, viscous, carboxymethylcellulose containing contrast material caused fatal cerebral embolism.

The examination was performed on a thirty-six year old woman with a known myoma uteri. After introduction of slightly more than 20 cc. of contrast material, the patient experienced a severe protracted epileptiform seizure. Following this she went into shock and expired in one-half hour despite immediate therapeutic measures.

The autopsy revealed marked cerebral edema and numerous blood vessels in the choroid plexus plugged with contrast material. A few capillary pulmonary emboli were noticed. The volume of the uterine cavity was 3–4 cc. and its posterior wall contained a small hematoma.

In order to elucidate this incident, which is contrary to prevalent beliefs concerning water soluble contrast materials, animal experiments (on cats) were performed. The results, using the same contrast material, indicate that cerebral embolism will occur only in a state of hypotension.

To prevent such incidents, the authors suggest blood pressure control during hysterosalpingography and immediate administration of vasopressor drugs if the need arises.—*Walter G. Heiman, M.D.*

Genitourinary System

Vespignani, Luigi. Rene a spugna; (considerazioni su 9 casi). (Spongy kidneys; report of 9 cases.) *Ann. radiol. diag.*, 1958, *31*, 276–302. (From: Istituto di Radiologia degli Ospedali Civili Riuniti di Venezia, Venezia, Italy.)

The term "spongy kidneys" was first employed in 1938 by Lenarduzzi and, since that time, has been mentioned by several other investigators. "Spongy kidneys" is used to describe cystic dysplasia localized in the renal pyramids. This entity has distinct anatomic, pathologic and roentgenologic characteristics. The condition is presumed to be congenital and, in some respects, is similar to congenital polycystic kidneys, except that the collecting tubules appear to be the site of the pathology.

The clinical picture in spongy kidneys, although not characteristic, is usually one of chronic kidney infection, renal stones and hematuria. The disease runs a chronic course with acute exacerbations of renal pain and colic. The renal stones are usually small in size and located in the pyramids of the kidney.

The roentgenologic signs in this disease appear to be rather typical. The plain roentgenogram of the abdomen, in a high percentage of the cases, shows minute calcifications, sometimes in clusters, located in the pyramidal part of the kidney.

Excretory urography yields the highest percentage of correct diagnosis. Small collections of the contrast medium are seen, which appear as small diverticula about the minor calices of the kidneys. There is stasis of urine and contrast medium in the dilated collecting tubules and the minute calcification deposits are located within these areas.

Retrograde urography is less helpful as the dilated tubules may fail to be visualized by this method.

The author carefully reviews 9 cases of spongy kidneys. Seven cases were bilateral and 2 unilateral. There was a predominance of males to females, 7 to 2. The group included patients from the age of twenty-five to fifty-three.

In the differential diagnosis, tuberculosis, nephritis and necrotic papillitis must be considered.

The article contains many good illustrations of this disease. The author has reviewed the world literature and the bibliography is excellent. He believes that more cases will be diagnosed as this disease entity becomes better known.—*Peter E. Russo, M.D.*

LEADBETTER, GUY W., JR., and LEADBETTER, WYLAND F. Diagnosis and treatment of congenital bladder-neck obstruction in children. *New England J. Med.*, March 26, 1959, *260*, 633–637. (From: The Department of Urology, Massachusetts General Hospital, Boston, Mass.)

Unrecognized and untreated, congenital bladder-neck obstruction leads to vesical and upper urinary tract changes, and ultimately to progressive renal destruction and death.

Three types of obstruction may be found: hypertrophic muscle involving part or all of the circumference of the bladder neck; contractures due to the presence of increased amount of fibrous tissue; and chronic inflammatory change.

When disease of the urinary tract is suspected, a systematic urologic evaluation is in order. Following analysis of the history, a thorough physical examination and studies of the blood and urine, the authors' procedure is to obtain: a specimen of residual urine; an intravenous pyelogram to evaluate the presence, absence or severity of associated renal disease; a delayed and voiding cystourethrogram to evaluate the bladder neck and urethra and to determine the presence or absence of vesicoureteral reflux; a cystometrogram to detect neurogenic dysfunction; renal-function studies; and cystoscopy and panendoscopy under anesthesia.

The intravenous urogram may be misleading unless delayed and voiding cystograms are obtained. The intravenous urogram may appear normal, may reveal only minimal dilatation of the ureters or may even suggest uretero-pelvic-junction obstruction. A delayed or voiding cystogram may reveal the cause to be unilateral or bilateral vesicoureteral reflux associated with hydroureter and hydronephrosis.

The authors utilized both transurethral and retropubic methods for treatment of obstructed bladder neck. They now prefer open operation, with excision of all fibromuscular tissue and anterior Y-V vesical-neck procedure in children.—*John F. Weigen, M.D.*

WEMEAU, L. (Lille, France.) La tuberculose urétro-prostato-séminale. (Urethro-prostato-seminale tuberculosis.) *J. d'urol., Paris*, Dec., 1958, *64*, 754–793.

Opinion is divided as to whether genital tuberculosis is a complication of a renal lesion. It seems that a primary genital tuberculosis exists (*i.e.*, without a renal lesion), but statistics regarding the frequency vary greatly. Both lesions, whether primary in the kidney or genital tract, are metastatic from the lung but there is no agreement whether further spread is canalicular, lymphatic or hematogenous. At present, it is not known whether tuberculosis localizes in the superficial or deep genital tract but, without doubt, epididymitis is neither the cause nor the consequence of the prostate-vesicular focus. Urethral lesions in some cases are secondary to bladder disease, but in others arise from prostato-vesicular tuberculomas.

Tuberculosis of the urethra, prostate and seminal vesicles is diagnosed more frequently when roentgenologic investigations are carried out more often. These studies include vasography, urography, ureterography, cystography and urethrography (urethroseminal reflux).

In using simple roentgenography: (a) it is impossible to differentiate prostatic calculi from some tuberculous calcifications; (b) calcifications of the

vas deferens and seminal vesicles are likely to be tuberculous but are also seen in diabetics.

The ureterogram particularly shows juxtavesical stenosis which, however, resembles any other stricture or pressure by an enlarged lymph node. The important point is to examine the bladder and to perform vasography in the presence of this lesion.

The bladder may be deformed by tuberculous prostatitis but the deformity produced by vesiculitis is more important.

Urethrography demonstrates stricture with proximal dilatation. However, a rigid, sclerosed, dilated urethra may be present without stricture. Abnormal juxtaurethral opacifications may be seen with specific cavities and dilated prostatic canals and there may be a secondary urethroseminal reflux.

Deferens-vesiculography may be difficult to interpret and characteristic findings are rare. The canals of the vasa deferentia are enlarged, shortened and irregular. Stenosis may be present. Irregularity, rigidity, retraction and atrophy of the ampulla are also noted. The seminal vesicle may be dilated, ectatic, disorganized and irregular in outline. It may be amputated by a caseous mass or atrophied and reduced to a narrow channel. A fistula may be demonstrated by injection.—*Marcy L. Sussman, M.D.*

Wangermez, Jacques. (Bordeaux, France.) Aspects radiologiques des calcifications de l'appareil génital masculin. (Radiologic aspects of male genital tract calcifications.) *J. de radiol., d'électrol. et de méd. nucléaire*, May, 1959, *40*, 236–242.

Exploration of the male genital tract with contrast material (vesiculography or deferentography) is easily performed in radiosurgical centers. There are, however, some genital affections which produce calcifications and lead to a diagnosis on the plain roentgenograms. These calcifications are more frequent than is usually suspected and they should be systematically searched for.

The roentgenologic procedures are simple. When they are dense, pelvic calcifications are well demonstrated on a standard anteroposterior roentgenogram by the technique used for cysto- or urethrography. When they are more discrete, a minimal preparation of the patient is required to detect them. In particular, the rectum should be cleansed and, if necessary, may be inflated by a small balloon.

A lateral roentgenogram of the pelvis is helpful in localizing the spermatic passages in the sagittal plane, but presents no other interest. The umbilicococcygeal position, as employed in gaseous pelvigraphy, gives a wide open view of the pelvis. With this projection prostatic calcifications remain anterior, close to the pubis, whereas those of the vasa deferentia and seminal vesicles are more posterior.

Calcifications of vasa deferentia. When the ampullae are chiefly calcified, they produce the classic picture of "yak horns," the shadows being concave caudally and laterally. When the pelvic portions of vasa deferentia are impregnated with calcium, they rarely produce parallel lines, as vascular calcifications usually do, but are rather moniliform or serpentine. In the differential diagnosis, one must include the vascular calcifications which appear in the same area, usually as two parallel lines. Calcifications of vasa deferentia and ampullae are usually due to diabetes mellitus.

Calcifications of seminal vesicles. On the kidney-ureter-bladder roentgenogram, because of their posterior location, these calcifications are projected above the pubis. They constitute an aggregation of small nodules reproducing the configuration and direction of seminal vesicles. In 80 per cent of the published cases, the calcified vesicles were bilateral. The homolateral ampulla of vas deferens might also be involved by the calcifying process. Very often calcification of the prostate and epididymis is also encountered. The calcifications of the seminal vesicles are usually the result of a chronic infection such as gonorrhea and tuberculosis.

Calcifications of the prostate. These are calculi in the prostate gland or in some diverticula. The glandular calcifications are multiple; they lie behind the pubic bones and are symmetrically located on each side of the median line. They rarely coalesce and can be counted, being miliary grains. Usually they form a cluster of calcifications the size of a nut. The diverticular calculus is usually solitary and located in the periphery of a prostatic lobe. In the differential diagnosis, bladder calculi, phleboliths and seminal vesicle calcifications should be considered.—*Henri-Paul Lévesque, M.D.*

Lang, Erich K., and Davis, Hugh James. Positive pressure urethrography: a roentgenographic diagnostic method for urethral diverticula in the female. *Radiology*, March, 1959, *72*, 401–405. (Address: E. K. Lang, Department of Radiology, The Johns Hopkins Hospital, Baltimore 5, Md.)

The authors describe the use of a special urethrographic catheter utilizing balloons to obstruct the vesical neck and the external meatus so that the female urethra becomes a closed tube which can be filled with a contrast medium under moderate pressure. Anteroposterior and anterior oblique roentgenograms, using a 4 inch cone, are then obtained. A delayed roentgenogram is taken after removal of the catheter; residual filling of the diverticula has been noted in 58 of 62 cases with diverticula.

The authors believe that this diagnostic method is more accurate than the simple injection of contrast medium with a syringe or the use of voiding urethrograms after instilling the medium into the bladder.

An accurate preoperative localization of urethral diverticula is beneficial to the surgeon in facilitating the initial surgical approach and in the identification of various saccules during the procedure.—*John S. Alexander, M.D.*

GREEN, ROBERT C., JR., and BOYD, JOSEPH A. Rickets secondary to chronic hyperchloremic acidosis in ureterosigmoidostomy. *A.M.A. Arch. Int. Med.*, May, 1959, *103*, 807–813. (From: The Medical and Radiology Services, Community Memorial Hospital, South Hill, Va.)

This is a case presentation of rickets associated with long-standing hyperchloremic acidosis in a patient with a ureterosigmoidostomy. This patient exhibited not only the hyperchloremic acidosis, but also lowered values for serum calcium, phosphorus and potassium. He presented the roentgenographic picture of rickets.

The methods of production of hyperchloremic acidosis and hypopotassemia are well known. The low calcium and phosphorus values are not as well known or easily explained. Albright's concept of the utilization of calcium as a base to combine with excess acid does not exactly fit in this instance, and the authors state that a clear understanding of the calcium loss in this patient is not available.

There was good clinical, laboratory and roentgenologic response to therapy. This consisted of parenteral administration of M/6 lactate solution and later oral Scholl's solution and potassium triplex.—*John L. Gwinn, M.D.*

NERVOUS SYSTEM

SILVER, MAURICE L., FIELD, EUGENE A., SILVER, CAROLL M., and SIMON, STANLEY D. The postoperative lumbar myelogram. *Radiology*, March, 1959, *72*, 344–347. (Address: M. L. Silver, 102 Waterman St., Providence, R. I.)

The authors report on a study of 38 cases where myelography was performed because of recurrence of symptoms or failure to improve following previous laminectomy or hemilaminectomy for disk herniation. Initial myelographic studies had shown in all a definite lesion diagnosed as consistent with protrusion of one or more intervertebral disks in the lumbar region.

Of the 38 cases, 22 (58 per cent) showed postoperative myelographic findings which were considered to be within normal limits. The remaining 16 cases demonstrated the presence of a myelographic defect either at the same level or at another level. Subsequent surgery showed gross pathology consistent with the findings on the myelograms. In 5 cases the original myelographic defect was no longer present but a new defect was found at another level. In the other 11 cases a myelographic defect was found at the original level and at surgery was proved to be a recurrence of a herniated disk.

The authors conclude that a definite defect on the postoperative myelogram is evidence of disk protrusion of surgical significance and is not due to "adhesions," "arachnoiditis," or other sequelae of previous surgical intervention.—*Donald N. Dysart, M.D.*

SÖDERBERG, LENNART, SJÖBERG, SVEN, and LANGELAND, PER. Neurological complications following myelography with water-soluble contrast medium. *Acta orthop. scandinav.*, 1959, *28*, 220–223. (From: The Orthopaedic Clinic, and the Roentgenologic Clinic, Malmö, Sweden.)

Abrodil 20 per cent was first employed as a water-soluble contrast medium for myelography in 1931, but did not find extensive use until the 1940's. No neurologic side effects following myelography with this medium have previously been recorded in the literature. However, the solution is hypertonic, and its presence in the spinal canal is painful and can cause shock or spasm; consequently, the examination must be performed under spinal anesthesia.

The authors report 3 cases of neurologic complications in a total of 760 myelographies performed with abrodil at the Malmö General Hospital (0.4 per cent). The sequelae consisted of bladder and rectal dysfunction and impotence associated with hypesthesia and anesthesia of the inner surfaces of the thigh, genital, and anal regions. The symptoms were stubborn and regressed but slowly.

They conclude that the use of abrodil for myelography continues to be justified since it is the best contrast substance available for this purpose and since complications following its use are rare.—*Kenneth W. Lewin, M.D.*

SKELETAL SYSTEM

HÄSSLER, E. Familiäre kranio-metaphysäre Dysplasie. (Familial craniometaphyseal dysplasia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, June, 1959, *90*, 704–713. (From: Universitäts-Kinderklinik, Jena, Germany.)

The name "craniometaphyseal dysplasia" was first suggested by Jackson, Albright *et al.* (1954) for a disorder having the combined features of metaphyseal dysplasia and leontiasis ossea.

Two cases, a father and daughter, are described. In one patient, the daughter, who was followed from her second to her twenty-second year, the findings initially resembled osteopetrosis. The sclerotic changes in the tubular bones disappeared over the years and gave way to symmetric, club shaped expansions of the metaphyseal ends of the bone

shafts. Loss of differentiation of the cortex from the medulla in these areas was striking. Sclerosis of the base of the skull persisted in the young woman. The roentgen findings in the fifty-two year old father were similar; *i.e.*, there were symmetric Erlenmeyer flask like expansions of the metaphyseal bone ends with poor differentiation of the cortex from the medulla and poor mineralization. In addition, he showed overgrowth of the cranial vault and sclerosis of the base of the skull. Of interest, and contrary to expectation in this disorder, is the fact that the daughter developed a severe anemia at the age of twenty-one.

The literature is reviewed and the close relationship of this familial disorder to osteopetrosis, metaphyseal dysplasia and leontiasis is discussed. The author agrees that craniometaphyseal dysplasia represents a link between osteopetrosis and metaphyseal dysplasia.—*Walter G. Heiman, M.D.*

Bingold, A. C. Unusual skeletal dystrophy associated with a soft-tissue tumour. *Brit. J. Surg.*, March, 1959, *46*, 462–465. (From: The Department of Orthopaedics, Lewisham Hospital, London, England.)

This is a case report of a fourteen year old boy with a huge benign fibroma attached to the clavicle and scapula. Multiple congenital symmetric bone malformations were found involving particularly the wrists, feet, elbows and shoulders.

There is a reported family history of skeletal deformities although no roentgen studies are presented.

This case belongs to the group characterized by the coexistence of a skeletal disorder with a soft-tumor hamartoma. Bingold classifies it with neurofibromatosis with bone abnormalities and subcutaneous nodules, macrodactyly and macromelia with multiple cutaneous hemangiomata. Some cases of polyostotic fibrous dysplasia are associated with arteriovenous aneurysm and Maffucci's syndrome.—*Martha Mottram, M.D.*

Winfield, Alan C., and Dennis, J. M. Stress fractures of the calcaneus. *Radiology*, March, 1959, *72*, 415–418. (Address: A. C. Winfield, X-ray Department, Cedars of Lebanon Hospital, Los Angeles, Calif.)

Stress or march fractures were first recognized as an entity by Breithaupt in 1855. Since that time they have been described in many bones throughout the body, mainly in the lower extremities. They are most common in the metatarsals, tibia and fibula. Stress fractures of the calcaneus have been less frequently observed, the only extensive series (53) having been reported by Hullinger in 1944.

The authors present a series of 12 cases which were discovered in a five month period beginning January, 1958 in the recruits of the U. S. Marine Corps Recruit Depot in San Diego, California. About 8,700 men in their late teens and early twenties were processed during this period.

Clinically, the patient experiences a gradual onset of pain and swelling of the heel. There is usually no history of acute trauma, but symptoms frequently develop shortly after a vigorous march, "double timing," or running an obstacle course. Most cases are diagnosed as tenosynovitis of the Achilles tendon.

Lateral and axial roentgenograms usually show a dense line of increased bone reaction just anterior and parallel to the posterior epiphyseal line of the calcaneus. The cortex may or may not be cracked. There is usually neither displacement or loss of Böhler's angle, nor involvement of an adjacent joint surface. At least one week after onset of symptoms, but usually longer, is required before positive roentgen findings occur. Treatment consists mainly of reduced weight bearing until symptoms subside.

In a three month period following the submission of the above paper, the authors found 21 additional cases. Of these 21 cases, 6 were bilateral. Two of the original patients with unilateral fractures suffered fractures of the contralateral calcaneus. Bilateral involvement, either simultaneously or subsequently, occurred in 38 per cent of the present series.—*Z. Petrany, M.D.*

Jayne, E. Howard, and Meaney, Thomas F. Van Neck's disease—fact or fiction? *Cleveland Clin. Quart.*, April, 1959, *26*, 84–90. (From: Department of Radiology, Cleveland, Ohio.)

Van Neck in 1924 described swelling and demineralization of the ischiopubic synchondrosis with local pain and soft tissue reaction. Biopsy showed osteochondritis and there was clinical relief after incision and drainage.

Since that time many cases have been considered osteochondritis because of the roentgen findings. However, it has been repeatedly shown that many asymptomatic children particularly from six to ten years of age have swelling and osseous irregularity of the ischiopubic synchondrosis prior to fusion which usually occurs between four and twelve years. The authors confirmed this by roentgen examinations of 86 asymptomatic children.

Van Neck's disease is a rare entity and this diagnosis should not be made on the basis of the roentgen findings alone.—*Martha Mottram, M.D.*

Epstein, Joseph A., and Epstein, Bernard S. Neurological and radiological manifestations associated with spondylosis of the cervical and lumbar spine. *Bull. New York Acad. Med.*, June, 1959, *35*, 370–386. (From: The Division of Neurological Surgery, Department of Surgery and the Department of

Radiology, The Long Island Jewish Hospital, New Hyde Park, N. Y.)

Spondylosis originates as a degenerative lesion of the intervertebral disk, involves the adjacent vertebral margins and narrows the canal and foramen. Spurs are usually demonstrated along the anterolateral margins of the vertebral column. The patients may be asymptomatic, but when the spurs project posteriorly or posterolaterally into the spinal canal or foramina, pressure effects and circulatory disturbances of the cord or nerve roots may result. The true extent of such spur formations may not be realized unless they are ossified. Trauma is poorly tolerated and may cause abrupt neurologic changes. Symptoms may be progressive and must be differentiated from amyotrophic lateral sclerosis, multiple sclerosis, tumors and herniated disks.

Cervical Spine. With involvement in the cervical region there may be awkward gait, spasticity and ataxia. Numbness of the hands, with atrophy and loss of finger coordination usually follows. Pain may be absent. Reflexes are usually depressed in the upper arms and hyperactive in the legs and wrists. Sensory levels are poorly defined.

Fifteen patients aged forty-two to sixty had symptomatic cervical spondylosis. The first changes involved the lower extremities in 10 patients with gradual onset of unsteady gait, spasticity, weakness and muscle atrophy. Restricted painful motion of the neck was present in only 2 patients. The symptoms were progressive and all 4 limbs were ultimately involved in the majority of these cases. Only 2 patients showed no sensory abnormalities.

Roentgen studies showed spondylosis at the C 5–6 and C 6–7 levels in all cases and at the C 5–4 level in some; rarely were there changes at higher levels. Spurs projected posteriorly into the spinal canal, the foramina were constricted and the disk narrowed; this could best be shown by myelography because of insufficient density of the ridges. Horizontal filling defects at the disk levels and deformity of the axillary pouches were found. Three patients had complete or partial block.

Decompression and laminectomy were done with 3 deaths (2 in the immediate postoperative period), poor results in 3, no change in 2, good results in 6 and exellent results in 1. When there is appreciable myelopathy of long duration, there may be irreversible alterations in the cord. One patient developed a postoperative thrombosis of the central retinal artery. They found surgery in the erect position preferable to the prone.

Lumbar Spine. Fourteen patients had symptomatic lumbar spondylosis. The majority had narrowing of one or more interspaces, osteophytes on the vertebral margins, and encroachment on the intervertebral foramina. If there is a narrow canal, even small spurs or disks can cause symptoms. Two patients showed negative roentgenograms and one had an isolated spur. Complete block was found in 3 patients and incomplete in 5, and there were axillary pouch deformities in the others. The disk tissue and osteophytes formed ridges in the oil column giving a "stepladder" or "washboard" appearance.

Pain and muscle weakness were present in the lower extremities of all patients. The pain was increased by standing, walking or sitting. Reflexes were depressed or absent. Other complaints included burning pain, numbness, coldness, cramping and sphincter changes. Nine patients had sensory changes.

Decompression with removal of osteophytes and ridges anterior and lateral to the canal was done in all patients. The authors attempted to remove the laminae, the yellow ligament and bony structure about the intervertebral foramen as well as the ridges. Degenerated disk material was also removed, although total protrusion of the disk was only found twice. There were no deaths. Four patients had excellent results, 4 good and 3 moderate, and there were 3 failures (2 because of sphincter difficulties and 1 because of intractable pain). Relief of pain was often striking after laminectomy.—*Martha Mottram, M.D.*

WILSON, JOHN C., JR. Degenerative arthritis of the lumbosacral joint; the end-space lesion. *J.A.M.A.*, March 28, 1959, *169*, 1437–1442. (Address: 2010 Wilshire Blvd., Los Angeles 57, Calif.)

This paper concerns a study of 125 patients with arthritis of the lumbosacral junction. The major cause of severe low back pain, with or without static radiation, is believed to be degenerative disease of the lumbar vertebral joints, especially the lumbosacral. While degenerative changes in the vertebral joints must be considered a normal process of aging, premature or accelerated degeneration of one joint, and hereditary predisposition to early degeneration of one joint are pathologic. In these 125 patients, the duration of symptoms prior to the initial examination varied from one to forty years. Every conceivable type of treatment has been rendered, including heat of all kinds, medicaments too numerous to record, supports of many types, exercises, traction and manipulation. Acute symptoms subsided in a few days regardless of what was done. With respect to manipulative therapy, questioning of the patient indicated that in the first years of their disease such treatment often gave relief. However, as the degenerative process of the lumbosacral joint progressed, manipulations either gave no relief or aggravated symptoms.

The diagnosis of lumbosacral arthritis can be strongly suspected from the history and physical findings, but accurate diagnosis depends upon roentgenographic examination. In view of the slowly progressive nature of the disease, serial roentgeno-

grams are sometimes needed before the diagnosis is confirmed. Roentgenograms should include anteroposterior and lateral views with oblique views and a coned view of the lumbosacral joint. Standing lateral roentgenograms of the lumbosacral articulation taken with the spine in flexion and extension are also helpful.

Patients with acute symptoms were treated conservatively with bed rest, anodynes, and physical therapy. In the chronic stage, the wearing of a brace often gave remarkable relief from pain. Forty-two patients were treated with lumbosacral fusion with varying results; complete relief from pain and recovery of motion was achieved in 18.—*John F. Weigen, M.D.*

Leger, W. Die Bedeutung der Wirbelsäulenganzaufnahmen für die Wirbelsäulendiagnostik. (The importance of the full-spine, single-film technique in diagnosis of spinal conditions.) *Radiol. clin.*, May, 1959, *28*, 129–138. (From: Orthopädische Universitäts-Klinik, Köln, Germany.)

By means of a motor-driven, rotating diaphragm made up of fine lead strips arranged like a fan, a satisfactory view of the entire spine can be produced on a single film. The focus-film distance is 3 meters. The focal spot is 2×2 mm. with a rotating anode and a 6-valve tube. The exposure to an average adult is 260 mr and 580 mr for the sagittal and lateral views, respectively. Roentgenograms are taken in the erect position; in the anteroposterior exposure, the patient leans against the cassette holder; in the lateral exposure, rubber supports are supplied for the chin, neck, and pelvis, while the arms are carried forward to clear the spine. The average, 2-film examination takes ten minutes, or about as long as 6 conventional roentgenograms of the entire spine would require.

The advantages of the full-spine, single-film technique are most appreciated in the follow-up studies of patients with severe scoliosis. Postural deformities of the entire spine are more readily apparent. Relationships between the cervical spine and head, as well as between the pelvis and lumbar spine, are also well demonstrated. The position of the hips with relation to the spine can also be studied.—*J. Zausner, M.D.*

Silberman, Fernando, Auday, José Horacio, and Kratz, Christa. Artrogriposis múltiple congénita. (Congenital multiple arthrogryposis.) *Rev. ortop. y. traumatol. Latino Americana*, March, 1958, *3*, 50–60. (Address: F. Silberman, Paraguay 2068-1° A, Buenos Aires, Argentina.)

The authors discuss the etiology, pathogenesis, incidence, pathologic anatomy, and other clinical details of this very complex disease. Apparently there are no definite osseous deformities but there is, instead, a muscular hypoplasia. This in turn is followed by a weakness of opposing muscle groups so that some joints are found in extension and others in flexion. The foot is extended in a rather high percentage of the cases. Also, there is a tendency for a prenatal dislocation of the hip. Some degree of relief is obtained in some cases by orthopedic surgical measures.—*Charles M. Nice, Jr., M.D., Ph.D.*

Perruelo, Nicolás N. (Buenos Aires, Argentina.) Xantoma de vainas sinoviales de la mano. (Xanthoma of the synovial sheaths of the hand.) *Rev. ortop. y. traumatol. Latino Americana*, March, 1958, *3*, 85–90.

The author describes 5 cases of xanthoma of the synovial sheaths of the hand, which occurs most frequently in female adults between the ages of twenty and fifty. The most common location is at the level of the metacarpal phalangeal joint or in the flexion fold. The roentgenographically demonstrable changes in the bones are secondary to erosion or invasion.

The tumor should be removed surgically. Recurrence is rare and it is thought that when metastases occur there has probably been an error in diagnosis.—*Charles M. Nice, Jr., M.D., Ph.D.*

Blood and Lymph System

Schwartz, Solomon, Handel, Jack, and Candel, Samuel. Azygography. *Radiology*, March, 1959, *72*, 338–343. (Address: S. Schwartz, 555 Prospect Place, Brooklyn 38, N. Y.)

A technique of intercostal venography to demonstrate the azygos system and internal mammary veins is described. Several variables contribute to the difficulty in the study of the physiology of the azygos system, *i.e.*, porosity of the ribs, position of the patient, and degree of intrathoracic pressure. Ordinarily, injection of a single rib results in opacification of several intercostal veins. Filling of axillary and phrenic veins without evidence of azygos obstruction is not uncommon in the course of the procedure. Opacification of the accessory hemiazygos and hemiazygos has not consistently been produced. Some intercostal veins that are supposed to communicate with the hemiazygos have been shown to drain directly into the azygos vein. The thoracic portion of the azygos often appears to be much further to the left than has been indicated. This has been seen in left atrial enlargement and atelectasis of the left lung causing a shift of mediastinal structures to the left. Complete block is obvious and is accompanied by retrograde flow; however, retrograde flow without clinical evidence of obstruction has been observed repeatedly. Despite these problems, the chief value of azygography lies in demonstration of

the operability of mediastinal masses. The procedure is much simpler than angiocardiography.—*Walter H. Jarvis, Jr., M.D.*

RÖSCH, J. Die Rolle der Splenoportographie in der Diagnostik der Epigastriumgeschwülste. (The role of splenoportography in the diagnosis of tumors in the epigastrium.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, April, 1959, *90*, 415–434. (Address: Praha 5-Brevnov V. Borcové 2, Czechoslovakia.)

The splenic and portal veins run close to the region of the pancreas and kidneys, and the lymph nodes present in the neighborhood of these veins are involved frequently with primary and metastatic tumors. Tumors in the epigastrium produce changes in the form, course, size, or degree of filling, of the veins. These changes are well demonstrated by splenoportography, which yields significant information regarding the tumor. Also, the entire inner structure of the liver can be visualized by the filling of the portal vein, thus not only showing the tumor itself but also its position, extent, the presence of multiple new growths, and, in some cases, its nature. In the central portion of the liver, nodules 1.0 cm. in diameter may be revealed. Splenoportography is, therefore, of aid in establishing the operability of the neoplasm and in planning the operation. A negative splenoportographic study does not exclude an epigastric tumor.—*Samuel Richman, M.D.*

FRANCHINI, A., and MARFISI, A. La splenoportografia nella diagnosi delle malattie del pancreas; osservazioni personali. (Splenoportography in the diagnosis of pancreatic diseases; personal observations.) *Ann. radiol. diag.*, 1959, *32*, 69–77. (From: Istituto di Clinica Chirurgica Gen. e Terapia Chirurgica, dell'Università di Bologna, Bologna, Italy.)

The authors report their observations in 4 cases of pancreatic disease using splenoportography as the method of investigation. Three of the cases were neoplasm of the pancreas and 1 cystic suppuration. All of the cases investigated showed changes or obstruction of the splenoportal system by serial roentgenographic examination. Manometry of the spleen was used in conjunction with this procedure.

The authors recognize the fact that disease processes in this vicinity, although non-pancreatic in nature, may produce similar changes of the splenoportal system, but the clinical picture, laboratory findings and splenic manometry should be used as a guide to the correct diagnosis.

The 4 cases presented are accompanied by excellent illustrations. The authors evaluate their findings and emphasize that this method may be used to help establish this diagnosis, especially in conditions involving the body and tail of the pancreas, which present more difficult problems than lesions located in the head of the pancreas.—*Peter E. Russo, M.D.*

BLOCKER, T. G., JR., SMITH, JAMES R., DUNTON, FRANK E., PROTAS, JACOB M., COOLEY, ROBERT M., LEWIS, STEPHEN R., and KIRBY, E. J. Studies of ulceration and edema of the lower extremity by lymphatic cannulation. *Ann. Surg.*, June, 1959, *149*, 884–897. (From: The Departments of Surgery [Plastic and Maxillofacial] and Radiology, University of Texas Medical Branch, Galveston, Texas.)

Using cannulation techniques, the authors have investigated the role of the lymphatics of the lower extremity in the pathogenesis of chronic edema, ulceration, and vascular lesions of one type or another. Cannulation studies were performed on 65 clinical subjects, 25 being normal persons. In addition, 35 experiments were conducted on dogs.

The lymphatic channels were identified by the color method and cannulated with appropriate sized needles. Intralymphatic pressures were read by means of an electromanometer bridge and amplifier connected to an electrocardiograph. Lymphangiography was carried out using 50 per cent miokon. Lymph flow studies were made during radical neck dissection by injection of 1 ml. (10 μc/ml.) of RISA (radioactive iodinated serum albumin) into a foot lymphatic vessel with the patient in the horizontal position and under general anesthesia. Samples of lymph fluid were collected simultaneously at varying intervals from the thoracic duct and from a systemic vein nearby, and radioactivity was determined in a well scintillation counter.

Cannulation of the lymphatics of the lower extremity, followed by recording of intralymphatic pressure measurements in mm. H_2O, and roentgenologic visualization of the lymphatic structures of the lower leg and thigh, provides a reliable technique for investigation of some of the pathologic physiologic changes which occur in the so-called lower leg syndrome and in other abnormal states. Studies in normal clinical subjects and in normal extremities of several patients with involvement of the lymphatics on one side, as well as experimental work in dog limbs, have demonstrated that intralymphatic pressures are characteristically subatmospheric. Pressure becomes atmospheric or positive with edema, blockage of the lymphatic channels by scar tissue or removal of the inguinal lymph nodes, and, at least in the dog, following acute trauma and anoxia. There appears to be some correlation, in the limited series of the authors, between the degree of positive pressure and the severity of the lesion. The rapidity with which changes occur following acute injury in the experimental animal and the absence of pathologic findings in those leg ulcer patients, whose swelling

has subsided on bed rest and elevation, suggest that chronicity *per se* is not the dominant etiologic factor in the production of lymphedema, unless congenital developmental anomalies are present. Studies on lymph flow indicate that fairly rapid drainage does occur in the normal patient at complete rest and in the horizontal position. Interpretation of the pathology and hydrodynamics of the lymphatics for diagnostic and prognostic purposes should help to clarify our knowledge of chronic edema and ulceration of the lower extremity.

The standardization of lymphatic cannulation technique has suggested a number of therapeutic possibilities for treatment of infection and malignancy in both the lower extremity and other regions of the body. Although dye has been utilized for localization of lymph nodes in regional dissection, it stains the field and interferes with accurate dissection; it is possible that injection of radioisotopes and the use of a surgical probe counter may prove a more useful tool. Certainly the diagnostic possibilities of cannulation are still largely unexplored.—*William C. MacCarty, Jr., M.D.*

RADIATION THERAPY

Betsch, Cl., and Croll, R. Les cancers de la paroi postérieure de l'oro et de l'hypopharynx; étude radiographique et radiothérapique. (Cancers of the posterior wall of the oro and hypopharynx; radiographic and radiotherapeutic study.) *J. de radiol., d'électrol. et de méd. nucléaire*, May, 1959, *40*, 221–229. (From: Fondation Curie, Paris, France.)

This is a study of 45 cases of cancer of the posterior wall of the oro and hypopharynx treated by radiation therapy. The material represents 5 per cent of all treated cancers of the oro and hypopharynx (913 cases, those of the tonsils being excluded).

The boundaries of the oro and hypopharynx are defined and three important anatomic features are pointed out: the immediate proximity of the carotid artery to the mucosa behind the posterior pillar; the lymphatic network which decreases in density from above downward; and finally the distribution of the lymph nodes.

These rare cancers seem to develop only in males, usually between forty-five and seventy years of age. Two macroscopic forms are encountered and described: the exophytic type (rare) and the ulcero-infiltrative type (more frequent).

Clinically, dysphagia is the most common symptom, then the presence of lymphadenopathy and, less frequently, pain radiating to the ear. This last symptom occurs in the infiltrative, highly situated lesions.

The carcinoma is located by mirror examination and by palpation, and its extent is determined by roentgenographic examination. The technique routinely employed at the Curie Foundation yields more information than any other type of examination and should be regarded as a masterpiece of roentgenologic investigation. As a rule, 4 roentgenograms are taken in the lateral projection, one before and one after thin coat opacification and both of these are repeated with the Valsalva maneuver.

In accordance with the statement made on lymphatic drainage, the more posteriorly situated a lesion is, the rarer is the occurrence of lymphadenopathy, whereas lesions on the posterior aspect of the posterior pillar are almost always accompanied by lymphadenopathy. However, the presence of a positive lymph node does not seem to have much prognostic value. Histologic grading and the extent of the lesion do not seem to influence the prognosis either. What appears to be the most important factor in the prognosis is the macroscopic aspect of the lesion. While the rare exophytic type responds well to irradiation and offers the best chances for cure, the infiltrative form is very deceiving and has an extremely doubtful prognosis.

In the authors' series, metastases to lungs or liver have been found accompanying sterilized lesions of the posterior pillar. On the other hand, in lesions involving the posterior wall, a new cancerous lesion was often discovered after radiation treatment, usually localized at the level of the cervical esophagus.

The treatment in all cases was carried out with two cervical portals opposing each other and an anterior complementary one. In this procedure the larynx is fully preserved. A tumor dose of 5,000 r or more is delivered in six to eight weeks using a 200 kv. beam filtered by 1 mm. Cu and 2 mm. Al. Very high dosage will cause necrosis of the cartilages and, rather than improving the patient's condition, brings about death by hemorrhage.—*R. L'Abbé, M.D.*

Baily, Norman A., and Yoder, Virgil E. Isodose curves for horizontal rotation therapy with 2 MVP roentgen rays. *Radiology*, March, 1959, *72*, 406–411. (Address: N. A. Baily, Department of Radiation Therapy, Roswell Park Memorial Institute, Buffalo 3, N. Y.)

The use of rotation roentgen therapy in the horizontal plane has certain advantages over other forms of therapy under a variety of circumstances. One disadvantage it has, however, is the necessity of using wax cones in conjunction with the wedge filter for the purpose of focusing the useful beam. The present study is a report of the experimental findings using a newly designed wedge filter which eliminates the need of wax cones. Using the filter, radiation of 2 mv. peak energy level was directed into a water filled lucite tank, 53 $cm.^3$, at a target surface distance of 100 cm. Various sized ports and beam angles were used. Dosages were measured with a Bombke

dosimeter (with integrator attachment) at various levels throughout the phantom. The imaginary tumor depths and angulation of the beam were chosen to cover as wide a variety of clinical situations as seemed feasible with this technique. Dosage readings were recorded and isodose contours were drawn for each experimental arrangement.

Tumor-air ratios for each field size, tumor depth and beam angulation were determined and are tabulated. The ratios of the integral dose obtained using horizontal rotation as against those obtained using two opposing ports of the same size were also recorded and are tabulated.

Using 2 mv. peak roentgen rays, the filter was shown to produce satisfactory isodose contours in the water phantom without the use of a wax cone.—*Z. Petrany, M.D.*

RADIOISOTOPES

NORDYKE, ROBERT A., and BLAHD, WILLIAM H. Blood disappearance of radioactive rose bengal—rapid simple test of liver function. *J.A.M.A.*, July 4, 1959, *170*, 1159–1164. (Address: R. Nordyke, Veterans Administration Center, Wilshire and Sawtelle Boulevards, Los Angeles, Calif.)

The rate of disappearance of I^{131} tagged rose bengal dye from the blood stream, evidenced by multiple five minute counts over the head, provides a simple test of liver function.

Repeated tests made by the authors were consistently within acceptable range. Normal values fell between 39–51 per cent. The tables presented show a narrow margin between the normal values and those obtained in disease conditions, such as viral, chronic and acute hepatitis. Multiple tests may be carried out serially on the same patient to follow the course of the disease. The simplicity of the test is impressive.—*Jesshill Love, M.D.*

COLBY, MALCOLM Y., JR., and ORVIS, ALAN L. The part-thigh ratio: a useful aid in evaluating the uptake of I^{131} by thyroidal cancer. *Radiology*, March, 1959, *72*, 394–400. (Address: M. Y. Colby, Jr., Mayo Clinic, Rochester, Minn.)

A simple, reliable technique is described for the *in vivo* determination of distribution patterns of radioactivity in patients who have received tracer doses of radioiodine in order to detect or evaluate suspected regions of abnormal radioactivity. The method consists of measuring the counts per second recorded by placing a properly collimated detector in contact with certain standard parts on the body (the right and left midanterior chest, liver, and spleen), always including a site over the anterior lower thigh, and calculating the ratio of counts per second over the part in question to the counts per second over the thigh. If, on scanning, abnormal foci are found anywhere in the body, ratio readings are made directly over these areas. Usually symmetric parts of the body may serve as controls in determining the significance of any given ratio. Counts are made routinely at twenty-four and forty-eight hour intervals.

A total of 263 determinations of part-thigh ratios were made on 201 patients. In the normal group each determination yielded four part-thigh ratios: right and left midanterior areas of the chest, the liver, and the spleen. Graphing the part-thigh ratios against the twenty-four hour thyroid uptake of radioiodine showed that the counts over the chest increased as the uptake of radioiodine by the thyroid increased, due to scattered radiation from the thyroid gland. The ceiling ratio for both right and left sides of the chest seems to be about 10. The counts for the spleen and liver are not influenced by the thyroid uptake, presumably because of their greater distance from the gland, and the part-thigh ratios for these sites are less consistent than those for the chest, probably because of variations in the volume of blood and differences in hepatic concentration of radioiodine-tagged metabolites. Nevertheless, there appears to be a ceiling ratio of about 11 for spleen-thigh ratios, and about 9 for liver-thigh ratios. The ratios in patients with thyroidal cancer without metastasis did not differ in any essential from those of the normal group.

Generally speaking, in cases in which abnormal twenty-four hour ratios are found, the determinations should be repeated at twenty-four hour intervals for ninety hours, if possible, to determine whether the high ratio is due simply to increased concentration of radioiodine in the blood or to protein-bound radioiodine in a metastatic process. A high ratio due to increased concentration in the blood will usually fall on each successive day; if it is due to protein-bound iodine, it will usually rise each day. However, the forty-eight hour chest-thigh ratios tended to be slightly higher than the twenty-four hour ratios in the majority of cases in normal patients and patients with thyroidal cancer without metastasis due to scatter from the normal thyroid, whereas the liver-thigh and spleen-thigh ratios tended to be lower than those obtained at twenty-four hours.

Some of the advantages of the part-thigh ratios over the common practice of simply recording the counts per second over various standard parts are as follows: (1) It is not necessary to maintain a standard tracer dose. (2) The values obtained are not as greatly influenced by "competitive" radioiodine uptake in other areas of the body (for example, the normal thyroid gland or an avidly functioning metastatic lesion) as are simple counts per second readings. However, the counts over the chest are influenced by the percentage of the dose of radioiodine in the thyroid because of scattered radiation from the

gland. (3) The values obtained offer a crude, completely empiric, but useful relative measure of the uptake of radioiodine in the part in question. (4) Chronologically successive studies on the same patient are simplified because of the preceding three factors, and a quantitative yardstick of effectiveness of treatment with radioiodine on the radioiodine-concentrating capacity of a metastatic lesion is available. "Ratio counting" requires no equipment that is not generally available even in the smallest isotope laboratory.

Two cases of carcinoma of the thyroid with metastasis are presented to illustrate the value of the part-thigh ratio technique both in diagnosis and in measuring progress of the post-treatment clinical course.—*Walter H. Jarvis, Jr., M.D.*

Beierwaltes, William H., Lowrey, George H., Aster, Richard A., Raman, Govind, and Carr, Edward A., Jr. Congenital hypothyroidism; a preventable cause of mental retardation. *J. Michigan M. Soc.*, June, 1959, *58*, 927–934. (From: Department of Internal Medicine and the Thyroid Research Laboratory, Kresge Medical Research Building, Medical Center, University of Michigan Medical School, Ann Arbor, Mich.)

Eighty-five cretins were studied to establish criteria for an earlier diagnosis of cretinism. Cretinism has long been known as a cause of mental retardation and the best results are obtained when the diagnosis is made early in life and treatment is started promptly. The average age at which cretinism was diagnosed in this series was four years and treatment was not started in most cases until the age of eight years. Since brain growth is 20 to 30 per cent complete at birth and approaches the maximum weight during the first seven years of extrauterine life, the treatment was ineffective in improving the mentality of the cretins.

The clinical findings noted at birth were: umbilical hernia, prolonged cyanosis and high birth weight. The postnatal findings in order of appearance were: feeding problem, retarded growth, prolonged icterus neonatorum, respiratory distress with cyanosis, constipation, lethargy, anemia, dry skin, hypothermia, bradycardia and classic cretinoid features. The distal femoral epiphyses and the talar bones were not ossified at birth in the cretins.

The basal metabolism rate and serum cholesterol tests were of little value in the early diagnosis of cretinism whereas the serum protein bound iodine and the twenty-four hour I^{131} uptake studies were of definite value. Maternal hypothyroidism was not a significant cause of fetal hypothyroidism. Substantial quantities of thyroid hormone were found to be transmitted across the placenta in humans and in dogs. It is believed that temporary congenital hypothyroidism may be a more common cause of mental retardation than previously suspected.

It is hoped that cretins can be diagnosed and treated as early as possible in order to permit them to develop into the normal range of intelligence.—*Charles W. Cooley, M.D.*

Calabresi, Paul, and Meyer, Ovid O. Polycythemia vera. I. Clinical and laboratory manifestations. *Ann. Int. Med.*, May, 1959, *50*, 1182–1202. (From: The Department of Medicine, University of Wisconsin School of Medicine, Madison, Wisconsin, and the National Cancer Institute, National Institutes of Health, Bethesda, Md.)

Polycythemia vera is an hematopoietic disorder of obscure etiology. It is, however, amenable to modern therapeutic measures and, for this reason, deserves a proper and early recognition. The present-day approach to the treatment of polycythemia vera centers chiefly about the use of radioactive P^{32}. The authors review here the report of other large series in which this isotope has been used and also report their own experience of 100 cases studied at the University of Wisconsin Hospitals.

The diagnosis of polycythemia vera is usually based on a clinical appraisal of the patient and confirmation by laboratory methods. Chief reliance is placed upon a persistently elevated red blood cell count and hemoglobin in the absence of any pertinent cause. The finding of an increased red blood cell mass together with a normal arterial oxygen saturation is essential in laboratory confirmation of an early diagnosis. Support of this diagnosis is offered in the presence of a slightly elevated leukocyte count or platelet count, or in the presence of hepatosplenomegaly.

The average age of the patient at the time of diagnosis was fifty-four. His symptoms relating to polycythemia were present on the average of two years prior to diagnosis. The ratio of male to female was approximately 2 to 1. In this series of patients no prevalence was found in any particular racial group or (particular) occupation.

The two most common presenting symptoms in patients having polycythemia vera were weakness and abdominal pain. It is interesting to note that more cases were discovered on incidental work-up than were found on recognition of such "classic" manifestations as thromboses, vertigo, erythema, or headache. In addition to these symptoms, others presenting included syncope, disturbances of the extremities, psychiatric manifestations, chest pain, dyspnea, visual complaints, paresthesias, pruritus, bleeding tendencies, abdominal tumor, high blood pressure, renal symptoms, constipation and hot spells. In the 540 cases reported from 6 other large clinics, the manifestations of this disease were also quite

numerous and variable but weakness, fatigue, and headache were the most common.

The physical findings in polycythemia were attributable to the characteristic increase in total blood volume and red blood cell mass. The visual signs resulting from vascular congestion were notable; including facial plethora, distended retinal veins, peripheral vasodilatation and cyanosis, congestion of oral and nasal mucosa, congestion of conjunctiva, as well as the palpable signs, splenomegaly and hepatomegaly.

The laboratory findings of polycythemia vera in the early erythemic stage are analyzed. The association with other conditions such as peptic ulcer, gout, and hypernephroma is briefly discussed. The need for further research in these fields is re-affirmed. —*Bernard S. Loitman, M.D.*

CALABRESI, PAUL, and MEYER, OVID O. Polycythemia vera. II. Course and therapy. *Ann. Int. Med.*, May 1959, *50*, 1203–1216. (From: The Department of Medicine, University of Wisconsin School of Medicine, Madison, Wisconsin, and the National Cancer Institute, National Institutes of Health, Bethesda, Md.)

The authors report their results in 97 cases of polycythemia vera treated at the University of Wisconsin Hospitals with radioactive phosphorus over the past ten years. Treatment prior to the use of P^{32} consisted mainly of venesections, Fowler's solution, and phenylhydrazine.

The treatment plan with P^{32} consisted of an initial oral dose of from 2 to 10 mc, depending upon body weight and erythrocyte count. The tendency has been to use smaller doses in recent years.

At the same time phlebotomies were done (500 cc. per venesection) to reduce the red blood cell count below 6,000,000. Laboratory examinations were made of the erythrocyte count, leukocyte count, and hemoglobin at each of the follow-up visits. The patient was considered in satisfactory control when he was asymptomatic and his erythrocyte count did not exceed 6,000,000. This control was maintained by a combination of phlebotomies and P^{32} administration.

Of the 97 patients treated with P^{32}, 28 have died; 6 (21 per cent) with chronic granulocytic leukemia and 2 (7 per cent) with myelofibrosis. In the light of present knowledge it is difficult or even impossible to separate these 3 myeloproliferative diseases (chronic granulocytic leukemia, myelofibrosis, and polycythemia vera). Furthermore, the authors believe that P^{32} therapy does not increase the incidence of leukemia over what may be expected with a longer survival time. Their median survival time in this series was eleven years from onset of symptoms and the median age at death was sixy-five years. Their figures are comparable to Lawrence's experience and represent an improvement over previous therapeutic measures. Of 78 patients followed at regular intervals, 67 (86 per cent) obtained satisfactory remission. The remaining 11 (14 per cent) all derived some benefit.

The following signs were found to be of prognostic value in predicting a poor response to P^{32} therapy: leukocyte counts over 25,000; relatively long duration of the disease; and marked splenomegaly.— *Bernard S. Loitman, M.D.*

LAWRENCE, JOHN H., and DONALD, WILLIAM G., JR. The incidence of cancer in chronic leukemia and in polycythemia vera. *Am. J. M. Sc.*, April, 1959, *237*, 488–498. (From: The Donner Laboratory and Donner Pavilion, University of California, Berkeley, Calif.)

From the authors' experience and from their review of the literature, there appears to be a very definite increase in the incidence of primary malignancies occurring in patients with previous malignancy. They report a series of patients seen at the Donner Laboratory with chronic lymphatic leukemia, chronic myelogenous leukemia, and polycythemia vera with other associated primary neoplasms.

In 162 cases of chronic lymphatic leukemia, 14 primary malignancies were found.

In 167 cases of chronic myelogenous leukemia, 7 primary malignancies were found. Tumors were found in the respiratory, gastrointestinal, genitourinary, musculo-skeletal, tegumental, and central nervous systems with no special predilection for any one site or organ system.

In the polycythemia vera series of 264 cases, 20 cases of malignancy were found; 3 of these were hypernephroma. This is in agreement with other reported series which also show a high incidence of associated renal neoplasm.

There is no indication from the analysis of the available figures that radiation therapy or the administration of radioisotopes has caused any increase in the incidence of malignancy. It is believed that patients with chronic leukemia and polycythemia vera have an increased susceptibility to malignancy. —*Bernard S. Loitman, M.D.*